

AD-A096 521 ARMY ENGINEER WATERWAYS EXPERIMENT STATION VICKSBURG--ETC F/6 13/2
H5320 - LOCK FILLING AND EMPTYING SYMMETRICAL SYSTEMS, PROGRAM --ETC(U)
JUN 78 F M NEILSON, M T HEBLER

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ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM

H5320 - Lock Filling and Emptying Symmetrical Systems, ✓

PROGRAM NO. Name

722-F3-RO-5J1,

PREPARING AGENCY

Hydraulic Analysis Division, Hydraulics Laboratory, U. S. Army
Engineer Waterways Experiment Station, P. O. Box 631, Vicksburg, MS. 39180

AUTHOR(S)

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Martin T. Hebler

DATE PROGRAM COMPLETED

March 1976

Documented June 1978

STATUS OF PROGRAM

PHASE

Origin

STAGE

Operational

A. PURPOSE OF PROGRAM

To determine the hydraulic performance of a lock culvert system.

LEVEL

DTIC

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B. PROGRAM SPECIFICATIONS

SEE FOLLOWING PAGES.

C. METHODS

The program is written in G635 time-share series, FORTRAN IV, and is part of a Conversationally Oriented Real-Time Program-Generating System (CORPS). The program consists of a main program, three function subprograms, and six subroutines. The specific function and relation of all these routines can be found in the FUNCTIONAL FLOW CHART, PART II: COMPUTER FUNCTIONAL DESCRIPTION of this abstract.

D. EQUIPMENT DETAILS

The program was developed and is operational on the WES G635, Vicksburg, MS. It is also operational on HIS66/80, Macon, GA, and Boeing CDC, Seattle, WA.

E. INPUT-OUTPUT

All inputs for program H5320 are either read from a permanent data file or are cued and read upon entry to the input subroutine DATA F. All specific input/output requirements for program H5320 are given in PART II: COMPUTER FUNCTIONAL DESCRIPTION of this abstract.

F. ADDITIONAL REMARKS

Complete documentation of this program is available from the Engineer Computer Programs Library, Technical Information Center, WES.

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B. PROGRAM SPECIFICATIONS:Language: ANSI FORTRAN (FORTRAN IV)Solution Requirements: The run command

RUN WESLIB/CORPS/H5320,R

plus the necessary input data.

Method of Analysis: A finite difference scheme is used to determine the flow rate through the culverts and water surface elevation in the chamber during a lock operation.

Core Requirements G635: 21 K words.

External Storage: Type of storage - disk. A user may have an input permanent data file with a maximum of 1 K G635 ASCII words. If the user does not have an input data file, one of the same size and user named will be created during a run of this program. If a user decides to save output for graphics and/or other use, a user named output file with a maximum of 13 K G635 ASCII words will be created. If the output file exists, then the existing output file is used.

General Equation: The governing equation is:

$$(k_1 + k_2 + k_v(t) + k_3 + k_4) \frac{V(t)^2}{2g} = \epsilon [Z_{\text{ref}} - z(t)] - \frac{L}{g} \left(\frac{dv}{dt} \right)$$

Where k_1 , k_2 , k_3 , and k_4 = constant loss coefficient values for the intake, upstream conduit, downstream conduit, and exit manifold.

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$k_v(t)$ = the valve loss coefficient which is a variable during valve opening and has a preset value of 0.1 for a full open valve

$V(t)$ = velocity of flow at a reference location in the culvert(s) at time t , fps

g = acceleration of gravity, 32.2 ft/sec^2

ϵ = operation type ($\epsilon = 1$ for filling; $\epsilon = -1$ for emptying)

Z_{ref} = upper pool elevation Z_u (filling) and lower pool elevation Z_L (emptying), ft-datum

$Z(t)$ = water-surface elevation in lock chamber at time t , ft-datum

L = culvert length, ft

$\frac{dv}{dt}$ = rate of change of velocity of water in the culvert at time t , ft/sec^2

Range of Quantities: Unlimited for practical applications.

Accuracy: Governed by accuracy of input data; the accumulative velocity error is a measure of the accuracy of the solution.

REF: ER 1110-1-10 - ENGINEERING AND DESIGN - Engineering Computer Program
Library Standards and Documentation, Appendix B

PART I: ENGINEERING DESCRIPTION

1. PROGRAM NUMBER: 722-F3-RC-5J1
2. TITLE: H5320 - Lock Filling and Emptying Symmetrical Systems
3. REVISION LOG: N/A
4. PURPOSE OF PROGRAM: The purpose of the program is to determine the hydraulic performance of a lock culvert system. The core of the program is a finite difference scheme which is used to determine flow rate through the culverts and water-surface elevation in the chamber during a lock operation. Once these are known, other important hydraulic parameters are evaluated. The program output contains the following computed quantities.

a. Single Values.

- (1) Operation time (T), min.
- (2) Overtravel (d_o), ft, and time (T_m), min., of occurrence.

b. Time Dependent Values.

- (3) Time (t), min.
- (4) Valve opening ratio (b/B).
- (5) Total inflow (Q), cfs.
- (6) Velocity head (h_v), ft, at the reference area.
- (7) Velocity head (h_{vv}), ft, just downstream from the valve.
- (8) Water-surface elevation (z), ft-datum, in the lock chamber.
- (9) Water-surface elevation (z_{uw}), ft-datum, in the upstream valve well.

- (10) Water-surface elevation (z_{dw}), ft-datum, in the downstream valve well.
- (11) Piezometric head (h_p), ft-datum, at the culvert roof just downstream from the valve.
- (12) Cavitation index (σ).
- (13) Average velocity (V), fps, in the culvert at the reference area.
- (14) Rate-of-rise (d_z/d_t), ft/min., of the lock chamber water surface.
- (15) Head losses (H_{l1} , H_{l2} , H_{lv} , H_{l3} , H_{l4} , and H_{LT}), ft, for culvert intake, upstream conduit, valve, downstream conduit, culvert exit, and overall culvert system(s), respectively.
- (16) Effective inertia (H_e), ft, in the flow in the culvert.
- (17) Overall drop ($H_t = H_{l1} + H_{l2} + H_{lv} + H_{l3} + H_{l4} + H_e$), ft, in water-surface elevation.

5. STEP SOLUTION:

a. Mathematical Formulation. The distribution of total head at an instant during a lock filling operation is assumed to be as shown in Figure 1; a comparable distribution is assumed for an emptying operation. The manner in which each item shown in Figure 1 is used in setting up the mathematical model is described in Table 1. Two simultaneous first-order differential equations are solved as a function of time (t); these equations are either equations (1a) and (2), or (1b) and (2), in the following listing.

(1) Conservation of Energy.

(a) Normal Flow $\frac{KV^2}{2g} = \epsilon(Z_{ref} - z) - H_e \quad (1a)$

or

$$(b) \text{ Reverse Flow} \quad \frac{-KV^2}{2g} = \epsilon(Z_{\text{ref}} - z) - H_e \quad (1b)$$

(2) Continuity (Normal and Reverse Flows)

$$\frac{dz}{dt} = \epsilon A_r V \quad (2)$$

The variables in equations (1a), (1b), and (2) are as listed in Table 1 with the following exceptions:

$K = k_1 + k_2 + k_v + k_3 + k_4$; where k_v and K are known functions of time.

$\epsilon = 1$ for filling
 -1 for emptying

$A_r = A_L / n_c A_c$; where A_L is the surface area in the lock chamber and

dz/dt = the rate-of-change of the elevation of the chamber water surface; dz/dt is positive for a rising water level.

The only boundary conditions prescribed are those when $t = 0$,

$z = Z_L$ for filling
 Z_u for emptying

$V = 0$

$K = \infty$

b. Time Steps. A known time (t_i) is advanced by a constant value (Δt) to a new time ($t_{i+1} = t_i + \Delta t$). Values of i that are of specific interest are listed below.

Value of i

Condition

1

Initial value (i.e., $t_i = 0.0$)

<u>Value of i</u>	<u>Condition</u>
N	Valve is fully open (i.e., $k_{i+1} = k_i$ for $i \geq N$)
M1	Lock operation is complete Filling: $z_{M1-1} < z_u \leq z_{M1}$ Emptying: $z_{M1-1} > z_L \geq z_{M1}$
M2	Maximum overflow or overempty Filling: $z_{M2-1} < z_{M2} > z_{M2+1}$ Emptying: $z_{M2-1} > z_{M2} < z_{M2+1}$
M	Final value (i.e., $t_M = (M - 1) \Delta t$)
<u>Known:</u>	$V_i, z_i, K_{i+1}, K_{i+2}$
<u>1st Prediction</u>	$V_{i+1} = F_p(z_i, V_i, K_{i+1})$ z_{i+1} from equation (4)
<u>2nd Prediction:</u>	$V_{i+2} = F_p(z_{i+1}, V_{i+1}, K_{i+2})$ $z_{i+2} = z_{i+1} + \epsilon \left(\frac{V_{i+2} + V_{i+1}}{2} \right) A_r \Delta t$ Iteration loop A
<u>Corrector:</u>	$V_{i+1} = F_p(z_i, V_i \text{ and } V_{i+2}, K_{i+1})$ z_{i+1} from equation (4)

Letting superscript $j = 1, 2, 3, \dots$ represents the number trials
(loop A above), the sequence is terminated when

$$(z_{i+1})^j - (z_{i+1})^{j-1} \leq 1(10^{-4})$$

In this program M is the overall control. For example, if M is pre-set to a value less than N the solution will terminate before the valve is full open (i.e., $M < N$); filling time and overtravel will not be evaluated.

c. Numerical Integration (Predictor-Corrector). Equations (2a) and (2b) are considered in the form

$$V_{i+1}^2 = \pm \frac{2g}{K_{i+1}} \left[\epsilon (Z_{ref} - z_{i+1}) - \frac{L}{g} \frac{dv}{dt}_{i+1} \right] \quad (3)$$

Equation (2), using a first-order difference, is approximated by

$$z_{i+1} = z_i + \epsilon \frac{V_{i+1} + V_i}{2} A_r \Delta t \quad (4)$$

The predictor is based on the backwards difference

$$\frac{dV}{dt}_{i+1} = \frac{V_{i+1} - V_i}{\Delta t} \quad (5)$$

Whereas the corrector uses the centered difference

$$\frac{dV}{dt}_{i+1} \approx \frac{V_{i+2} - V_i}{2\Delta t} \quad (6)$$

Substituting (4) and (5) in (3), and (4) and (6) in (3), yields the predictor, $F_p(z, V, K)$ and the corrector functions $F_c(z, V, K)$, respectively. The algebraic relationships are shown in Table 1; the sequence of calculations at each time step is as follows.

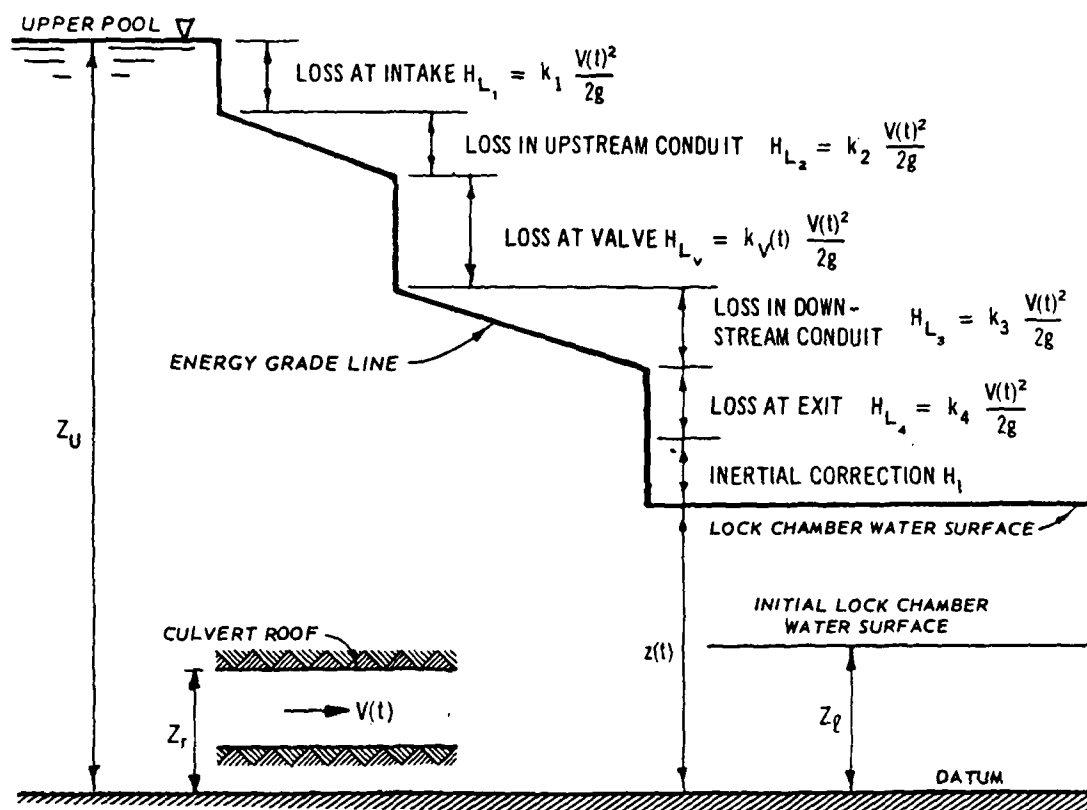


Figure 1. Simulated flow conditions at time t (filling operation)

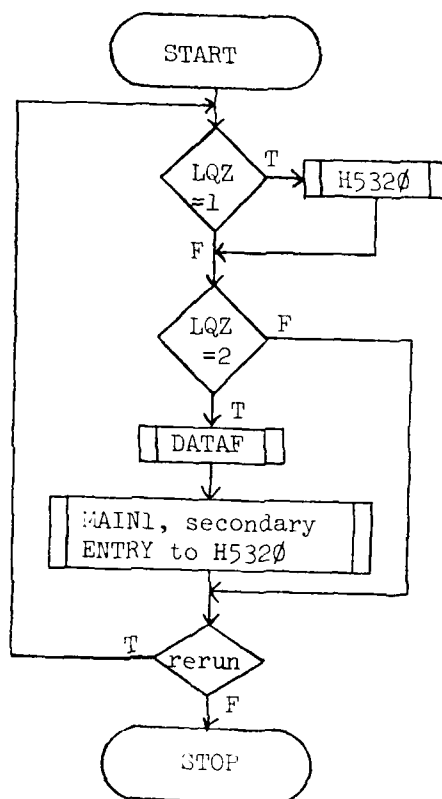
Table 1. Parameters Used in Setting Up the Basic Model

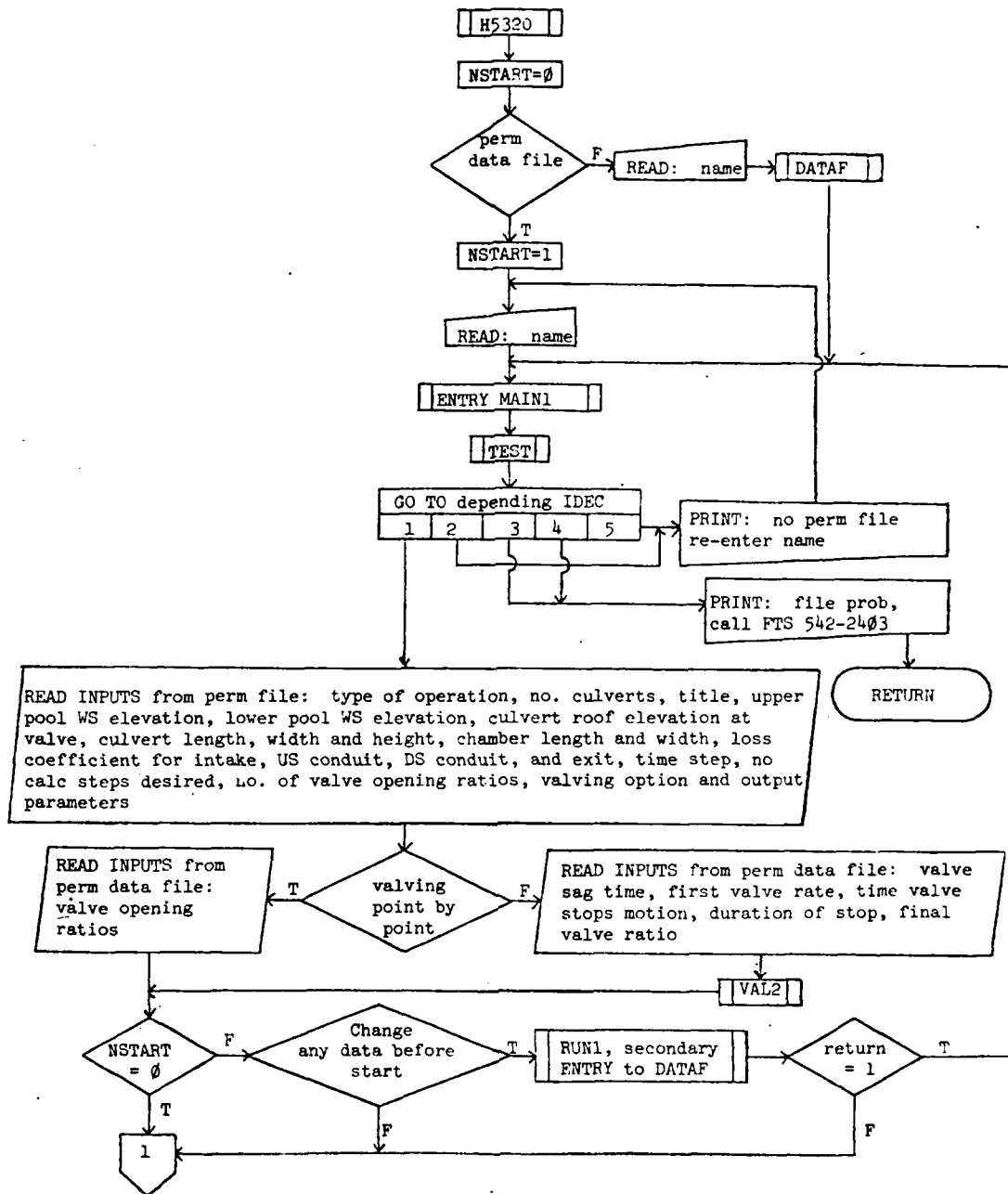
Item (Refer to Figure 1)	Type of Operation	Description
1. Fixed pool elevation, Z_{ref}	Filling	Z_u upper pool elevation
	Emptying	Z_L , lower pool elevation
2. Variable water-surface elevation (z)	Both	lock chamber water-surface elevation
3. Reference area, A	Both	$A = n_c A_c$, where A_c is the cross-sectional area of the culvert immediately below the valve, and n equals 1 or 2 for single or double valve operation, respectively.
4. Flowrate, Q	Filling	Total inflow (outflow is negative)
	Emptying	Total outflow (inflow is negative)
5. Reference velocity, V	Both	$V = Q/A$
6. Intake loss, $H_{l1} = \frac{K_1 V V }{2g}$	Filling	Headloss at the culvert intake; K_1 is constant
	Emptying	Headloss between the chamber and the culverts; K_1 is constant
7. First conduit loss, $H_{l2} = \frac{K_2 V V }{2g}$	Both	Loss in the culvert upstream from the valve; K_2 is constant
8. Valve loss, $H_{lv} = \frac{K_v V V }{2g}$	Both	Loss at the valve (K_v is a function of the valve opening ratio until full open; $K_v = 0.10$ thereafter)
9. Second conduit loss, $H_{l3} = \frac{K_3 V V }{2g}$	Both	Loss in the culvert downstream from the valve; K_3 is constant

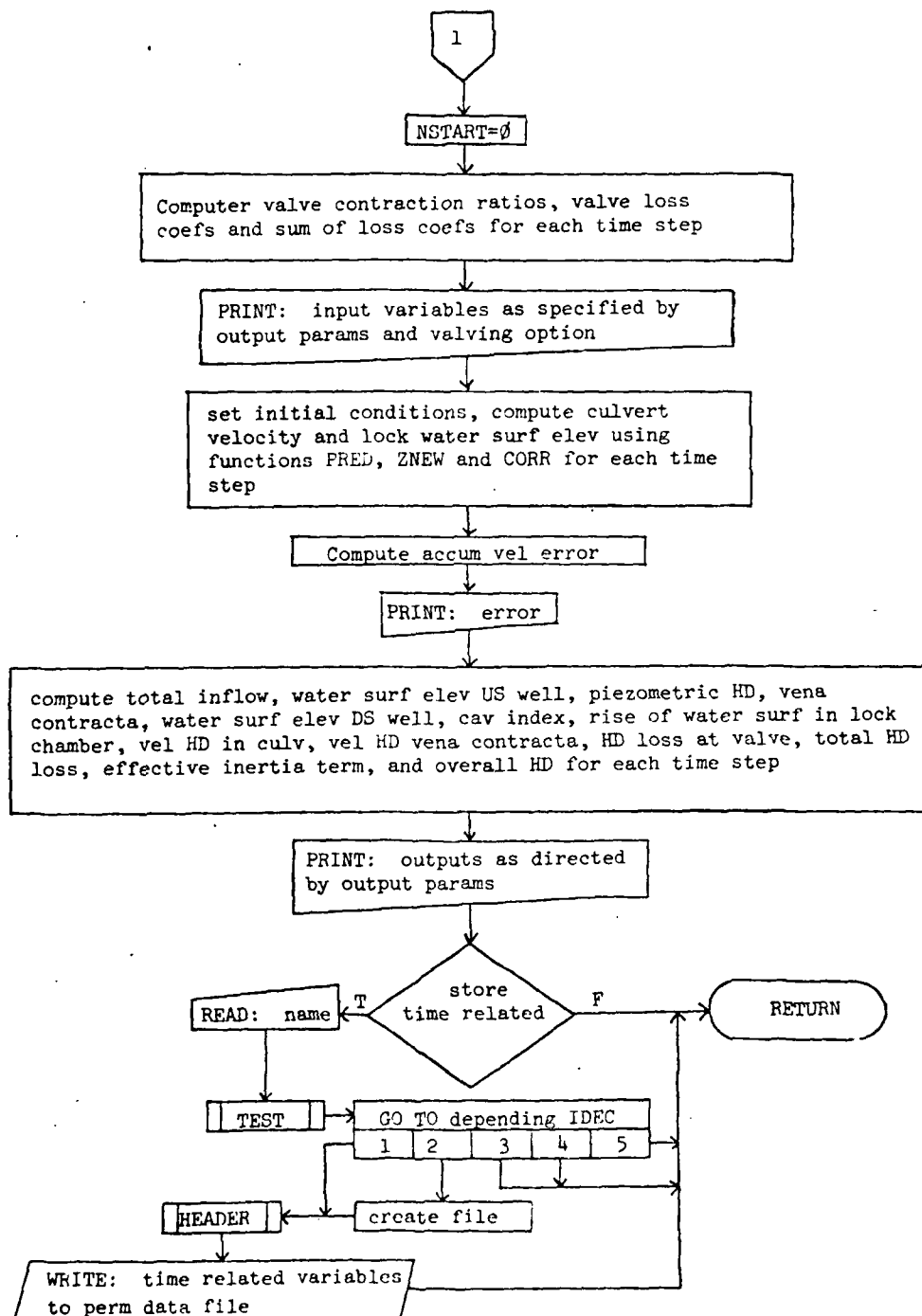
Item (Refer to Figure 1)	Type of Operation	Description
10. Exit loss, $H_{l4} = \frac{K_4 V V }{2g}$	Filling	Loss at the ports into the lock chamber, K_4 is constant
	Emptying	Loss at the downstream exit from the culvert; K_4 is constant
11. Inertia "head" $H_e = \frac{L}{g} \frac{dV}{dt}$	Both	The inertia "head" is placed at the downstream end of the culvert (i.e., along with H_{l4}); L is an effective culvert length, g is the acceleration of gravity, and dv/dt is the rate-of-change of velocity, V , with respect to time, t .

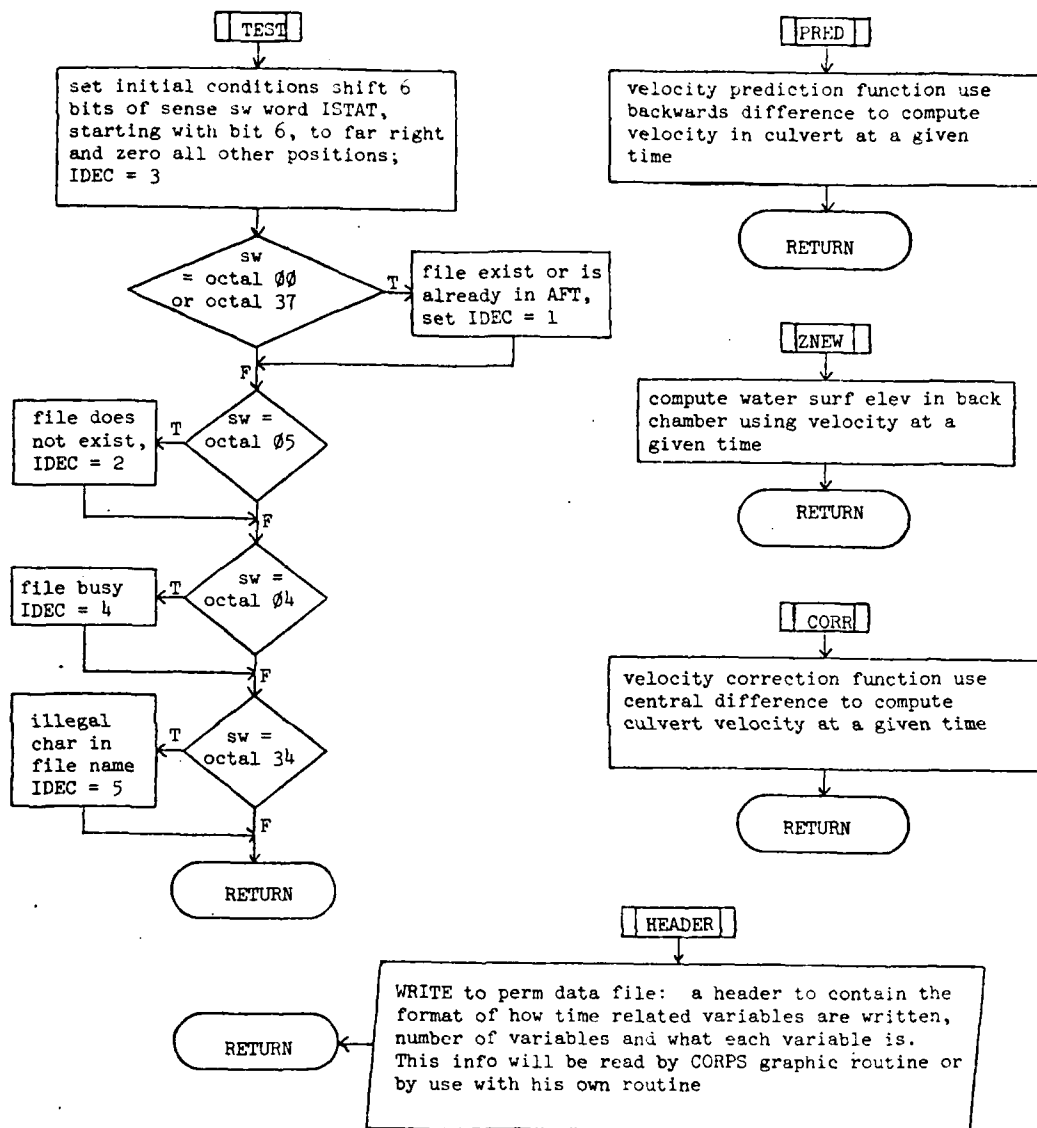
PART II: COMPUTER FUNCTIONAL DESCRIPTION

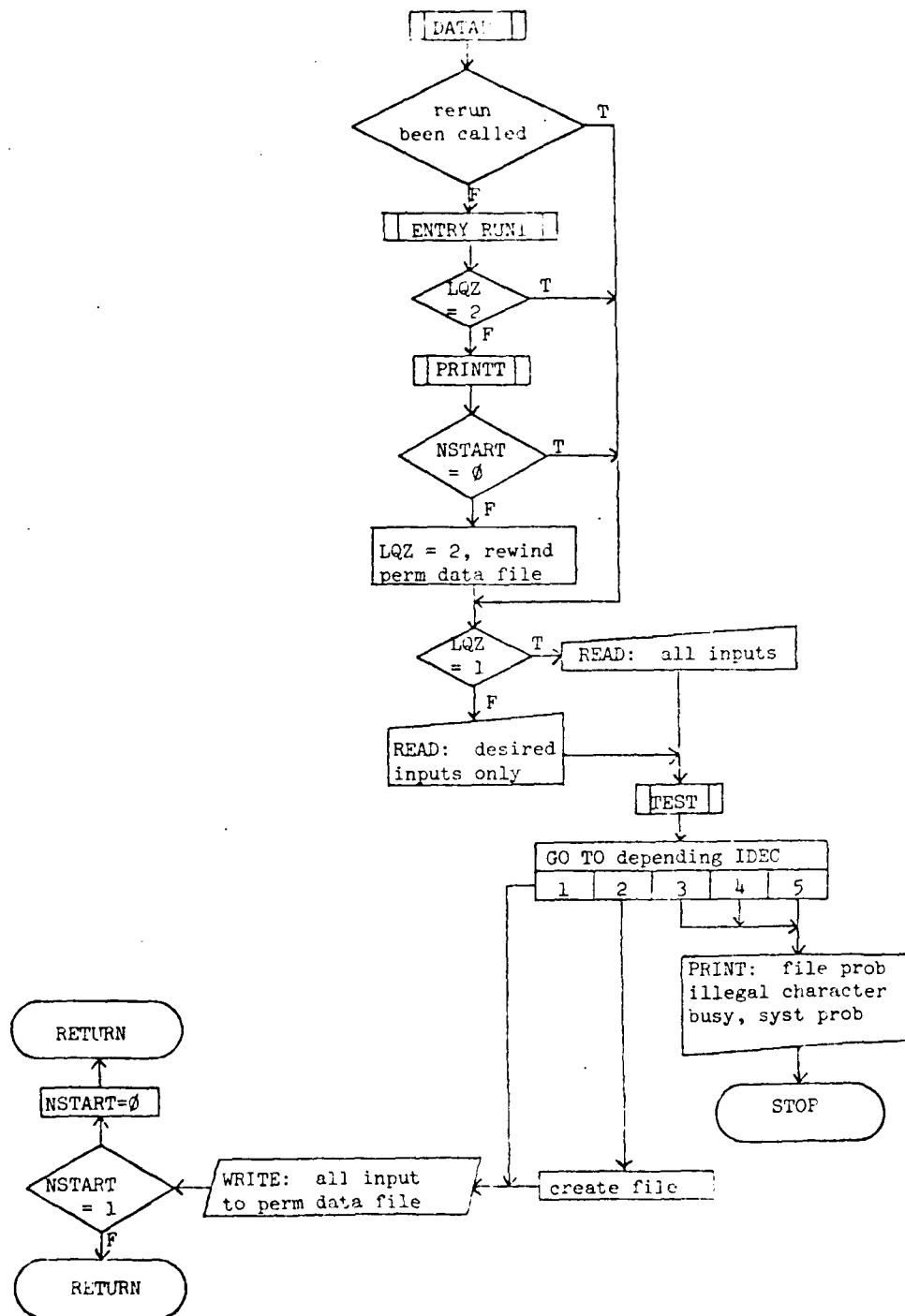
1. REVISION LOG: N/A
2. FUNCTIONAL FLOW CHART:

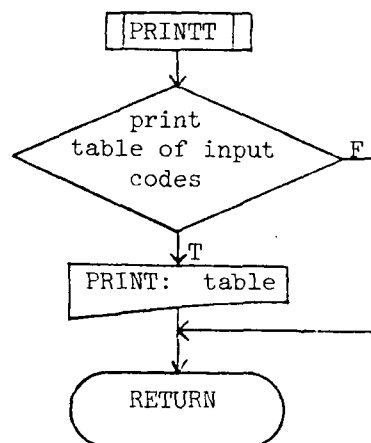
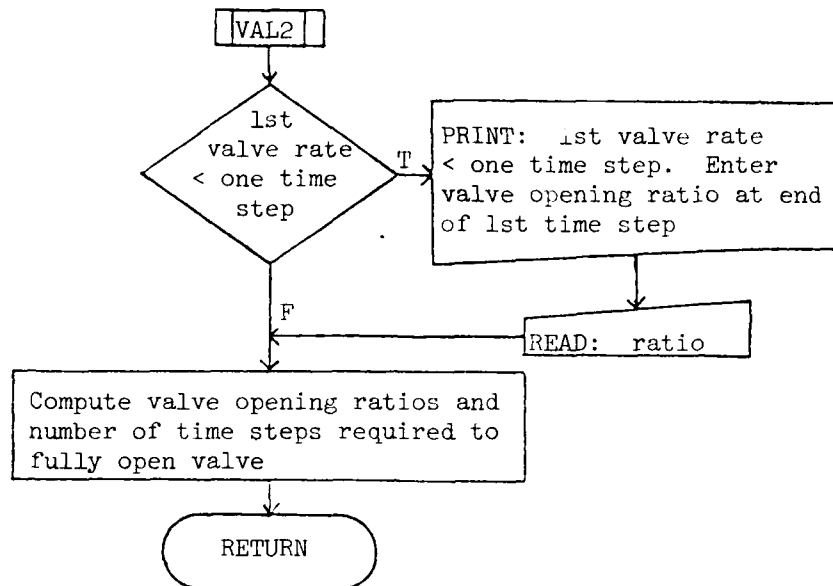












3. EQUIPMENT AND OPERATING SYSTEM: The program was developed on a G635 time-share system in which input/output equipment consisted of a Model 33 remote teletype. It is now operational on the WES G635, Vicksburg, MS; HIS 66/80, Macon, GA; and Boeing CDC, Seattle, WA.

4. INPUT REQUIREMENTS: The required inputs are entered via the user's time-share terminal device in free field format or are read from a permanent input data file. If the inputs are entered through a terminal device, then the input subroutine DATAF will supply all necessary cues and reads for the input data. A user named permanent file will be created by DATAF and the inputs written to it. All the inputs from DATAF are passed to the computation subroutine H5320 via the COMMON statement. If the inputs are entered from an existing data file, then the inputs are read directly by H5320. H5320 also handles all the required output.

5. SECONDARY STORAGE INPUT FORMAT:

a. The following formats are used for the input data file whether it already existed or was created by a run of program H5320.

To write:

56 FORMAT(I3,2F4.0,A35/I3,3F8.3/I3,5F8.3/I3,4F8.3/I3,F5.1,2I4,5I2)

57 FORMAT(I3,10F6.3)

To read:

10100 FORMAT(3X,2F4.0,A35)

10090 FORMAT(3X,3F8.3/3X,5F8.3/3X,4F8.3/3X,F5.1,2I4,5I2)

10110 FORMAT(3X,10F6.3)

Refer to line numbers 24160-24180 and 24200 or 24220 for variable matchup of the above write formats. Refer to 20690-20710 and 20740 or 20760 for read formats. These line numbers are in the source listings on pages 50, 43, and 44. An example data file is:

```

100  1.  2.EXAMPLE 2
102 262.800 169.500 128.000
104 390.000 12.000 14.000 685.400 86.000
106  0.200  0.060  0.180  0.850
108 10.0  31  17 2 1 0 1 3
110 0.120 1.000 0.500 2.000 3.000

```

b. If the user decides to save the time-related output for graphics or other use, then an existing user data file or a newly created user named file is written to in the following manner.

(1) Subroutine HEADER writes all of its header information to the file. This header information is used by the CORPS system for graphics use. If the user wishes to read only the time-related output from the data file, use the format as described in the second line of header information. Refer to line numbers 24900-25020 of the source listing on page 52 for a complete description of header formats.

(2) The time-related variables are written by the following format.

```

10430 FORMAT(I3,3F6.2,F8.3,F9.0,4F8.3/F9.2,2F6.2,F8.2,5F8.2)

```

Refer to line numbers 22100-22120 in the source listing on page 46 for variable matchup to the format. An example file is:

08 H5320 13 15 EDGE
 09 (15(/), (3X, 3F6.2, F8.3, F9.0, 4F8.3/F9.2, 2F6.2, F8.2, 5F8.2))
 10 31 31 31 31 31 31 31 31 31 31 31 31 31 31 31 31 31
 11 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
 12 C/P/E DESIGNATIONS FOR H5320 APE:
 13 1=TIME 10=CAVITATION PARAMETER
 14 2=VALVE OPENING PATIO 11=PATE-OF-PISE
 15 3=CONTRACTION COEF. 12=VELOCITY AT REF APEA
 16 4=LOG(VALVE LOSS COEF.) 13=VELOCITY HD AT REF APEA
 17 5=TOTAL INFLOW 14=VELOCITY HD AT VENA CONT
 18 6=LOCK WATER SURFACE(W-S) 15=HEADLOSS THRU VALVE
 19 7=W/S VALVE WELL W-S 16=TOTAL HEADLOSS
 20 8=PIEZ HD BELOW VALVE 17=INEPTIAL TERM
 21 9=D/S VALVE WELL W-S 18=W-S DIFFERENTIAL
 22 UNITS FOR ABOVE VARIABLES APE:
 23 MINUTES=1 FT/MIN=11
 24 NONE=2,3,4,10 FT/SEC=12
 25 CFS=5 FT=13,14,15,16,17,18
 26 FT-DATUM=6,7,8,9

100	0.	0.	0.30	4.00	0.	169.500	262.800	169.500	169.500
	9.99	0.	0.	0.	0.	93.30	93.30	0.	93.30
102	0.17	0.11	0.73	2.11	2190.	169.636	261.969	166.663	170.246
	0.88	2.23	6.52	0.66	95.97	84.19	85.04	8.03	93.11
104	0.33	0.23	0.70	1.47	4453.	170.249	259.363	157.576	172.563
	0.71	4.53	13.25	2.73	104.51	79.74	83.26	9.66	92.55
106	0.50	0.38	0.65	0.98	7548.	171.267	252.926	133.883	177.929
	0.39	7.63	22.47	7.34	126.88	75.53	85.64	5.92	91.53
108	0.67	0.33	0.65	0.98	7737.	172.564	252.427	127.374	179.561
	0.32	7.83	23.03	3.23	133.29	77.35	89.97	0.27	90.24
110	0.33	0.38	0.65	0.98	7699.	173.373	252.523	128.688	182.803
	0.33	7.84	22.91	8.15	131.99	78.53	69.09	-0.17	88.93
112	1.20	0.38	0.65	0.98	7644.	175.175	252.674	130.596	182.006
	0.35	7.78	22.75	3.04	130.11	77.46	87.33	-0.20	87.63
114	1.17	0.33	0.65	0.98	7533.	176.467	252.823	132.537	183.197
	0.37	7.72	22.53	7.92	123.20	76.32	86.54	-0.20	86.33
116	1.33	0.33	0.65	0.98	7531.	177.749	252.970	134.467	184.350
	0.40	7.67	22.41	7.30	126.30	75.19	85.25	-0.20	85.05
118	1.50	0.38	0.65	0.98	7475.	179.022	253.117	136.333	185.554
	0.42	7.61	22.25	7.63	124.42	74.07	83.93	-0.20	83.73
120	1.67	0.33	0.65	0.98	7418.	180.285	253.263	138.235	186.717
	0.44	7.55	22.03	7.57	122.55	72.95	82.72	-0.20	82.51
122	1.83	0.38	0.65	0.98	7362.	181.539	253.407	140.172	187.875
	0.46	7.49	21.91	7.45	120.69	71.85	81.40	-0.20	81.20
124	2.00	0.33	0.65	0.98	7305.	182.783	253.551	142.045	189.023
	0.47	7.44	21.74	7.34	118.85	70.75	80.22	-0.20	80.02
126	2.17	0.38	0.65	0.98	7249.	184.013	253.693	143.904	190.161
	0.51	7.33	21.57	7.23	117.22	69.66	78.99	-0.20	78.73
128	2.33	0.33	0.65	0.98	7193.	185.243	253.834	145.748	191.291
	0.53	7.32	21.41	7.12	115.20	68.58	77.70	-0.23	77.50
130	2.50	0.38	0.65	0.98	7140.	186.450	254.012	147.674	192.444
	0.55	7.17	20.95	6.32	110.05	65.69	74.49	1.02	76.35
132	2.67	0.44	0.66	0.32	6282.	187.743	251.147	150.011	195.604
	0.59	3.35	24.42	9.25	110.33	53.40	70.33	4.69	75.00
134	2.83	0.52	0.67	0.61	9045.	189.250	246.682	146.194	202.101
	0.53	3.32	23.72	12.79	113.23	51.56	63.00	5.43	73.54
136	3.00	0.56	0.69	0.40	11241.	191.028	240.903	143.752	205.804
	0.58	11.44	33.45	17.38	114.53	43.57	65.99	5.02	71.77
138	3.17	0.63	0.72	0.13	12373.	193.074	234.051	144.831	212.447
	0.51	13.19	33.31	22.79	112.04	34.74	64.14	5.67	69.73
140	3.33	2.72	0.74	-0.04	14333.	195.336	226.920	138.785	219.537
	0.60	14.65	42.32	23.47	104.66	25.84	62.57	4.97	67.41
142	3.50	0.77	0.72	-0.27	15629.	197.938	220.467	161.310	226.420
	0.77	15.91	40.52	33.00	92.75	17.65	61.19	3.81	64.87
144	3.67	0.95	0.82	-0.51	10501.	200.653	215.613	174.877	232.490
	1.03	16.39	45.11	37.45	78.19	11.49	59.88	2.46	62.14
146	3.83	2.92	0.86	-0.76	16992.	203.499	212.720	185.141	237.914
	1.53	17.30	52.57	37.71	63.33	6.97	53.20	1.80	59.30
148	4.00	1.00	0.90	-1.03	17201.	206.399	211.500	201.976	240.958
	2.16	17.51	51.19	40.70	50.74	4.07	50.57	-0.13	56.62
150	4.17	1.00	0.90	-1.00	16922.	209.294	213.175	205.937	242.771
	2.27	17.22	50.36	39.33	45.62	3.94	54.75	-1.23	53.51
152	4.33	1.00	0.90	-1.00	16500.	212.130	215.504	200.699	244.037
	2.44	16.82	49.17	37.54	46.34	3.75	52.13	-1.53	52.67
154	4.50	1.00	0.90	-1.00	16037.	214.690	217.949	205.599	245.153
	2.64	16.23	47.53	35.60	43.95	3.56	49.45	-1.57	47.90
156	4.67	1.00	0.90	-1.00	15647.	217.588	220.373	212.474	246.212
	2.86	15.93	46.57	33.67	41.57	3.37	46.36	-1.59	45.31
158	4.83	1.00	0.90	-1.00	15204.	220.285	222.740	215.233	247.219
	3.10	15.48	45.25	31.79	39.25	3.13	44.19	-1.62	44.59
160	5.00	1.00	0.90	-1.00	14760.	222.747	225.047	218.014	248.213
	3.20	15.02	43.93	29.97	36.99	3.00	41.65	-1.60	40.05

6. INPUT DATA DESCRIPTION: The following names are used for the input variables in program H5320.

AAB - 8 char name of perm data file

DTS - time step, sec

IDEL1 - output control to valve full open; = 1, print every time step value; = 2, print every 2nd value; = n, print every nth value

IDEL2 - output control from valve full open to complete solution; = 1, print every time step value; = 2, print every 2nd value; = n, print every nth value

IPRIN1 - output control for engineering values; = 1, print: conduit and chamber geometry, loss coefs and elevs; = 0, no print

IPRIN2 - output control for head loss distributions; = 1, print; = 0, no print

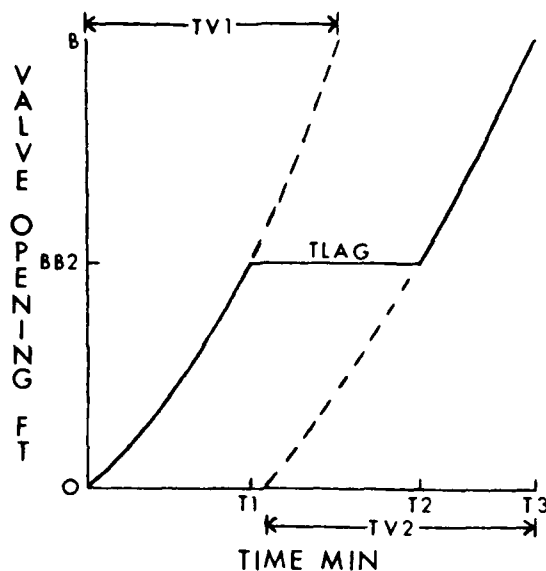
IVALV - type of valving; = 1, point by point; = 2, programmed functions

M - number of calculated steps desired

N - number of values of valve opening ratios (point by point)

RUN - 35 char problem name

SAG - sag at one-half valve time of the nondimensional valve opening pattern (programmed function)



- TV1 - first valve rate (programmed function), time taken for valve from closed to full open position with no stop, min to full open
- T1 - time valve stops initial motion (programmed function), min; no stop, $T1 = TV1$
- TLAG - duration of stop (programmed function), min; no stop, $TLAG = \emptyset$
- TV2 - second valve rate (programmed function), time taken for valve from closed to full open position as if no stop, min to full open. If actually no stop, $TV2 = TV1$, never \emptyset .
- TYPE - type of operation; = 1, filling; = 2, emptying; = \emptyset stop program
- XBB - valve opening ratios (point by point)
- XK1 - intake loss coef
- XK2 - upstream conduit loss coef

XK3 - downstream conduit loss coef
 XK4 - exit loss coef
 XL1 - culvert length, ft
 XL2 - culvert width, ft
 XL3 - culvert height, ft
 XL4 - chamber length, ft
 XL5 - chamber width, ft
 XN - number of culverts
 ZL - lower pool elev, ft-datum
 ZR - culvert roof elev at valve, ft-datum
 ZU - upper pool elev, ft-datum

7. OUTPUT DATA DESCRIPTION: All output is generated within subroutine H5320. It includes the given input data, plus the output data as described in the following variables.

BB2 - valve opening at end of first valve motion (programmed function), ft; Refer to figure given in (6) INPUT DATA DESCRIPTION
 CI - cavitation index
 ERROR - accumulated velocity error, ft^2/sec^2
 H - overall head, ft
 HI - effective inertia, ft
 HLT - total head loss, ft
 HLV - head loss at valve, ft

I - count of the number of time steps at which accumulated velocity error is printed

M1 - number of steps to fill or empty lock chamber, if input M (number of calculated steps desired) is sufficiently large to complete solution

M2 - number of steps to peak overflow or under empty, if input M is sufficiently large to complete solution

NC - number of culverts

Q - total inflow, cfs

RR - rise of water level in lock chamber, ft/min

T3 - valve opening time, min

V - velocity in culvert, fps

VH - velocity head in culvert, ft

VHVC - velocity head at vena contracta, ft

XBB - valve opening ratio

XCC - valve contraction ratio

XKC - equivalent lock coef (based on loss coefs)

XKT - sum of loss coefs (including valve) at valve full open

XKV - valve loss coef

XT - time at each calculation, min

XTM - time at extreme elev, min

CTX - time to complete operation, min

Z - lock chamber water surface elev, ft-datum

ZOW - water surface elev in downstream well, ft-datum

ZOT - Lock chamber overflow or empty, ft
ZUW - water surface elev in upstream well, ft-datum
ZV - piezometric head elev at vena contracta, ft-datum

8. PROGRAM ERROR MESSAGES:

a. If file name INDATA is entered as the name of your permanent data file and INDATA does not exist, then

NO FILE INDATA. ENTER FILE NAME OR STOP.

is printed from subroutine H5320. This is repeated until an existing file is attached or the reply STOP is entered. If STOP is entered, then control is returned to the main program. Since program only checks file to see if it exists, "be sure" file is your input data file. If not your data file, program will attempt to read bad data and/or abort.

b. If a program or system error occurs in an attempt to attach your data file, then

FILE PROBLEM. CALL FTS 542-2403 AND GIVE THIS NUMBER ISTAT
(where ISTAT is a 12 digit octal number)

is printed from subroutine H5320. Control is then returned to the main program.

c. If program cannot create or attach an output file for your request of an output data file, then

FILE PROBLEM;ILLEGAL CHAR;BUSY;OR SYSTEM PROBLEM
OUTPUT VALUES NOT SAVED AS REQUESTED

is printed from subroutine H5320. Control is returned to the main program.

- d. If first valve rate is less than one time step, then

YOUR 1ST VALVE RATE IS < ONE TIME STEP
ENTER VALVE OPENING RATIO AT END OF 1ST TIME STEP

is printed from subroutine VAL2. The ratio is read and program continues to next statement.

- e. If program cannot create or attach your input data file, then

FILE PROBLEMS;ILLEGAL CHAR;BUSY;OR SYSTEM PROB.

is printed from subroutine DATAF. Control is returned to the main program.

9. VARIABLE DEFINITIONS:

- a. Main program

HFILE - 5 char, name of program; passed to WESLIB, count routine
HACCT

LQZ - equal 1, execute all input cues and reads; equal 2,
call WESLIB routine RERUN and enter only desired inputs;
initialized to 1 in main program for first run,
2 thereafter

LQX - equal 1, print instructions for RERUN; equal 3 no print;
initialized to 1 in main program

ZZZZZ - 2 char; equal RE, rerun; equal ST, stop

- b. Subroutine H5320, main computation routine

AAA - 1 char; equal to Y for yes and N for no for response to
yes or no question

AAB - 8 char, name of permanent data file

AAC - 10 char, used for attaching permanent data file

AAD - 8 char, name of output file for graphics and/or other use

AAE - 10 char, used for attaching output file for graphics
and/or other use

AR - ratio of total culvert(s) cross-section area to lock
chamber water surface area

B - constant = 2.2, used to determine valve loss coef

BB1 - valve opening ratio at end of first valve motion
(programmed function)

BB2 - valve opening at end of first valve motion (programmed
function) ft

C - constant = 3.2, used to determine valve loss coef

CFILE - 25 char, used for creating output file for graphics
and/or other use

CI - cavitation index

CORR - velocity correction FUNCTION subprogram (central differ-
ence), fps

D - constant = .65, used to determine valve contraction coef

DTM - time step, min

DTS - time step, sec

E - constant = .9, used to determine valve contraction coef

ERROR - accumulated velocity error, ft^2/sec^2

F - constant = .9, used to determine valve contraction coef

H - overall head, ft

HI - effective inertia term, ft

HLT - total head loss, ft

HLV - head loss at valve, ft

HL1 - intake head loss, ft

HL2 - upstream conduit head loss, ft

HL3 - downstream conduit head loss, ft

HL4 - exit head loss, ft

I - count of the number of time steps

IDEC - switch equal to:

1 - file exist or is in AFT	2 - file nonexistent
3 - file problem	4 - file busy
5 - illegal char in file name	

IDEL1 - output control to valve full open; = 1, print every time
step value; = 2, print every 2nd value; = n, print every
nth value

IDEL2 - output control from full open to completed solution;
= 1, print every time step value; = 2, print every 2nd
value; = n, print every nth value

IPRIN1 - output control for engineering input variables; = 1,
print; = \emptyset , no print

IPRIN2 - output control for loss distribution; = 1, print; = \emptyset ,
no print

IVALV - type of valving; = 1, point by point; = 2, programmed
function

IVAL1 - switch variable set to \emptyset to be passed to subroutine
DATAF

IVAL2 - switch variable set to \emptyset to be passed to subroutine
DATAF

KK - switch variable set to \emptyset to be passed to subroutine
DATAF

LINE - line numbers in output file for graphics and/or other
use

M - total number of calculated steps desired

M1 - number of steps to fill or empty lock chamber if M is
sufficiently large to complete solution

M2 - number of steps to peak overflow or under empty if M
is sufficiently large to complete solution

M3 - switch; omit corrector sequence for low velocity flows

N - number of valve opening ratios

NC - number of culverts

NSTART - switch; = 1 if input is first read from permanent data
file, else = \emptyset

PRED - velocity prediction FUNCTION subprogram (backward
difference), fps

Q - total inflow, cfs

RR - rise of water in lock chamber, fpm

RUN - 35 char problem name

SAG - sag at one-half valve time of the nondimensional valve opening pattern (programmed function)

T1 - time valve stops initial motion (programmed function), min

TLAG - duration of stop (programmed function), min

T3 - valve opening time, min

TV1 - first valve rate (programmed function), time taken for valve from closed to full open with no stop, min to full open

TV2 - second valve rate (programmed function), time taken for valve from closed to full open as if no stop, min to full open. If actually no stop, TV2 = TV1, never \emptyset

TYPE - type of operation; = 1, fill; = -1, empty; = \emptyset , stop program

V - velocity in culvert, fps

VH - velocity head in culvert, ft

VHVC - velocity head at vena contracta, ft

XBB - valve opening ratios

XCC - valve contraction ratios

XK - sum of loss coefs (including valve)

XKC - equivalent lock coef (based on loss coefs)

XKT - sum of loss coefs (including valve) at valve full open

XKV - valve loss coef

XK1 - intake loss coef
XK2 - upstream loss coef
XK3 - downstream loss coef
XK4 - exist loss coef
XL1 - culvert length, ft
XL2 - culvert width, ft
XL3 - culvert height, ft
XL4 - chamber length, ft
XL5 - chamber width, ft
XN - number of culverts
XT - time at each calculation, min
XTM - time at extreme elev, min
XTX - time to complete operation, min
YY - working storage
Z - lock chamber water surface elev, ft-datum
ZCHEC - lock chamber water surface elev at time t_{i+1} , ft-datum
ZOW - water surface elev in downstream well, ft-datum
ZNEW - lock chamber water surface FUNCTION subprogram to
evaluate successive elevs, ft-datum
ZL - lower pool water surface elev, ft-datum
ZOT - lock chamber overfill or under empty, ft
ZR - culvert roof elev at valve, ft-datum
ZREF - upper pool water surface elev, filling; lower pool water
surface elev, emptying; ft-datum

ZU - upper pool water surface elev, ft-datum
 ZUW - water surface elev in upstream well, ft-datum
 ZV - piezometric head elev at vena contracta, ft-datum

c. Function PRED, velocity prediction function; uses backwards difference to evaluate the culvert velocity at a given time.

AR - ratio of total culvert(s) cross-section area to lock chamber water surface area
 DTS - time step, sec
 PRED - symbolic name of single valued function used as the return for the output value to the calling program, fps
 TYPE - type of operation; = 1, filling; = -1, emptying
 VST - culvert velocity at time t_i or t_{i+1} , fps
 XB - working storage
 XC - working storage
 XKF - sum of loss coefs (including valve) at time t_{i+1} or t_{i+2}
 XL1 - culvert length, ft
 ZREF - upper pool water surf elev, filling; lower pool water surface elev, emptying; ft-datum
 ZST - lock chamber water surface elev at time t_i or t_{i+1} , ft-datum

d. Function COOR, velocity correction function; uses central difference to evaluate the culvert, velocity at a given time.

AR - ratio of total culvert(s) cross-section area to lock
chamber water surface area

CORR - symbolic name of single valued function used as the re-
turn for the output value to the calling program, fps

DTS - time step, sec

TYPE - type of operation; = 1, filling; = -1, emptying

VAH - culvert velocity at time t_{i+1} or t_{i+2} , fps

VST - culvert velocity at time t_{i-1} or t_i , fps

XB - working storage

XC - working storage

XKF - sum of loss coefs (including valve) at t_{i-1} or t_i

XL1 - culvert length, ft

ZREF - upper pool water surface elev, filling; lower pool water
surface elev, emptying; ft-datum

ZST - lock chamber water surface elev at time t_{i-1} or t_i ,
ft-datum

e. Function ZNEW, evaluate water surface elev in lock chamber using
velocity at a given time.

AR - ratio of total culvert(s) cross-section area to lock
chamber water surface area

DTS - time step, sec

TYPE - type of operation; = 1, filling; = -1, emptying

VF - culvert velocity at time t_{i+1} , fps

VST - culvert velocity at time t_i , fps

ZNEW - symbolic name of single valued function used as the
return for the output value to the calling program,
ft-datum

ZST - lock chamber water surface elev at time t_i , fps

f. Subroutine TEST, determine status codes returned by file system
for an attach operation.

IDEC - decimal value for status codes; IDEC =
1 - file exist or is in AFT
2 - file nonexistent
3 - file problem
4 - file busy
5 - illegal char in file name

ISTAT - status code (12 digit octal number) returned by file
system; converted to decimal as represented by IDEC

ITEST - 2 digit octal number = 00, 04, 05, 34 or 37; used as
test against status code ISTAT to determine IDEC value

g. Subroutine VAL2, called if valve option is programmed functions.
Computes valve opening ratios and number of time steps to fully open
valve.

A - sag at one-half valve time of the nondimensional valve
opening pattern

BB1 - valve opening ratio at end of 1st time step

DTM - time step, min

DTS - time step, sec

N - number of values of valve opening ratios

PI - constant = 3.141593
 TLAG - duration of stop, min
 TV1 - first valve rate, time taken for valve from closed to
 full open with no stop, min to full
 TV2 - second valve rate, time taken for valve from closed to
 full open as if no stop, min to full. If actually no
 stop, TV2 = TV1, never = \emptyset
 T1 - time valve stops initial motion, min
 T2 - time at which valve motion starts following the partial-
 open stop, min
 T2N - working storage
 T2S - working storage
 XBB - valve opening ratios
 XT - time at each calculated ratio, min

h. Subroutine DATAF, supports inputs via teletype and rerun option.

All variables are as described in subroutine H5320 except:

CFILE - 24 char, used for creating a permanent input data file
 LQZ - equal 1, execute all input cues and reads; equal 2, call
 WESLIB routine RERUN and enter only desired inputs

IVAL1 and

IVAL2 - switch pair for setting value of rerun option LQZ

IVAL1 and IVAL2 sets LQZ

1	\emptyset	2
\emptyset	1	2

all other conditions, switch ignored

KK - switch for rerun option LQZ; KK = 1 sets LQZ = 2; any other value of KK, switch ignored

KKK - total number of inputs, passed to RERUN

JKL - direct return from RERUN to desired input read

LQX - equal 1, print instructions from RERUN; equal 3, no print

i. Subroutine PRINTT, provides a listing of input variables at the teletype during a run of program H5320.

AAA - 1 char; = N, no print listing; = Y, print

j. Subroutine HEADER, called if desire output stored for graphics and/or other use. HEADER writes a heading to the output file which contains the format the file was written in, the number of time related variables written and what each variable is, and the type of axis to graph the data on. The time related variables are then written under the heading.

M - number of calculated steps

10. EXAMPLE CASE: Determine the hydraulic performance of a lock culvert system during a filling operation.

a. Input Data:

Type operation	1
Problem title	Example 1
No. culverts	2
Upper pool elev, ft-datum	262.80
Lower pool elev, ft-datum	169.50
Culvert roof elev, ft-datum	128.00
Culvert length, ft	390.00
Culvert width, ft	12.00
Culvert height, ft	14.00
Chamber length, ft	685.40

Chamber width, ft	86.00
Intake loss coef	0.20
U. S. loss coef	0.06
D. S. loss coef	0.18
Exit loss coef	0.85
Time step, sec	10.00
No. of stepped values	73
Type of valving	2
Valve sag at 1/2 open time	0.12
First valve rate, min	4.00
Time valve stops motion, min	4.00
Duration of stop, min	0.00
Final valve rate, min	4.00
Output control, engr inputs	1
Output control, loss distribution	1
First output rate	1
Final output rate	3

b. Output:

EXAMPLE 1

CONDUIT GEOMETRY: LENGTH = 390.0 FT. WIDTH = 12.0 FT.
 HEIGHT = 14.0 FT. N = 2-CULVERT OPERATION)

CHAMBER GEOMETRY: LENGTH = 685.4 FT. WIDTH = 86.0 FT.

LOSS COEFFICIENTS: INTAKE 0.200
 UPSTREAM CONDUIT 0.060
 DOWNSTREAM CONDUIT 0.180
 MANIFOLD 0.850
 TOTAL (VALVE OPEN) 1.390 LOCK COEF. = 0.848

ELEVATIONS: UPPER POOL 262.80
 LOWER POOL 169.50
 CULVERT ROOF 123.00

VALVE OPENS AT 4.00-MIN. RATE FOR 4.00 MINUTES

ACC. VEL. ERROR TO I = 58 IS 0.00595
 ACC. VEL. ERROR TO I = 64 IS 0.00598

LOCK FILLS TO UPPER POOL IN 9.56 MINUTES
 EXTREME ELEVATION AT TIME = 10.50 MINUTES
 MAX COMPUTED OVERTRAVEL = 1.57 FT.

VALVE PARAMETERS					ELEVATIONS (FT-DATUM)				
TIME OPEN.	CONT.	LOSS	TOTAL		LOCK	"S VALVE	PIEZ. HD	DS VALVE	
(M) RATIO	COEF.	COEF.	INFLOW		CHAMBER	WELL	VALVE	WELL	CAV. PAR.
			CFS						
0.	0.00	0.80	10000.00	0.	169.50	262.80	169.50	169.50	9.99
0.17	0.03	0.80	2147.81	556.	169.55	262.75	164.34	169.53	0.84
0.33	0.05	0.79	531.46	1115.	169.69	262.58	163.62	169.83	0.83
0.50	0.08	0.79	232.25	1631.	169.93	262.31	162.38	170.26	0.80
0.67	0.11	0.73	127.64	2258.	170.26	261.92	160.56	170.86	0.77
0.83	0.14	0.76	79.36	2848.	170.69	261.39	158.07	171.64	0.72
1.00	0.17	0.75	53.25	3452.	171.23	260.74	154.80	172.62	0.67
1.17	0.20	0.73	37.63	4075.	171.87	259.92	150.37	173.81	0.60
1.33	0.23	0.70	29.23	4585.	172.60	259.16	151.25	175.06	0.61
1.50	0.26	0.63	22.63	5147.	173.43	258.21	148.24	176.52	0.57
1.67	0.30	0.65	17.28	5799.	174.35	256.97	140.57	178.29	0.47
1.83	0.34	0.65	13.00	6554.	175.40	255.36	140.19	180.42	0.46
2.00	0.38	0.65	9.64	7424.	176.59	253.25	138.10	183.03	0.44
2.17	0.42	0.66	7.04	8414.	177.93	250.53	134.95	186.21	0.40
2.33	0.47	0.67	5.06	9520.	179.45	247.09	131.43	190.05	0.36
2.50	0.51	0.68	3.59	10726.	181.17	242.86	128.59	194.62	0.33
2.67	0.56	0.69	2.51	11994.	183.10	237.87	127.25	199.92	0.31
2.83	0.61	0.71	1.73	13269.	185.24	232.29	128.43	205.82	0.32
3.00	0.67	0.73	1.18	14477.	187.59	226.48	132.81	212.10	0.37
3.17	0.72	0.75	0.80	15542.	190.14	220.94	140.53	218.38	0.46
3.33	0.77	0.73	0.53	16400.	192.85	216.19	151.06	224.29	0.60
3.50	0.83	0.81	0.35	17016.	195.68	212.62	163.36	229.54	0.82
3.67	0.89	0.84	0.23	17389.	198.60	210.40	176.21	233.95	1.12
3.83	0.94	0.87	0.15	17542.	201.57	209.47	188.57	237.54	1.52
4.00	1.00	0.90	0.10	17548.	204.54	209.43	199.50	240.54	2.03
4.50	1.00	0.90	0.10	16364.	213.19	216.39	207.75	244.50	2.51
5.00	1.00	0.90	0.10	15035.	221.18	223.62	216.33	247.61	3.20
5.50	1.00	0.90	0.10	13704.	228.49	230.25	224.19	250.45	4.10
6.00	1.00	0.90	0.10	12373.	235.13	236.27	231.33	253.03	5.30
6.50	1.00	0.90	0.10	11042.	241.09	241.67	237.74	255.34	6.96
7.00	1.00	0.90	0.10	9711.	246.37	246.46	243.41	257.40	9.36
7.50	1.00	0.90	0.10	8380.	250.97	250.63	248.36	259.18	9.99
8.00	1.00	0.90	0.10	7049.	254.90	254.19	252.59	260.71	9.99
8.50	1.00	0.90	0.10	5718.	258.15	257.13	256.08	261.97	9.99
9.00	1.00	0.90	0.10	4387.	260.72	259.47	253.84	262.97	9.99
9.50	1.00	0.90	0.10	3056.	262.61	261.18	260.86	263.71	9.99
10.00	1.00	0.90	0.10	1725.	263.83	262.28	262.19	264.18	9.99
10.50	1.00	0.90	0.10	394.	264.37	262.77	262.77	264.39	9.99
11.00	1.00	0.90	0.10	-833.	264.24	262.73	262.63	264.16	9.99
11.50	1.00	0.90	0.10	-1446.	263.64	262.59	262.30	263.39	9.99
12.00	1.00	0.90	0.10	-1393.	262.89	262.60	262.34	262.67	9.99

	RATE		VEL HDS(F)		DIFFERENTIAL HDS(F)			
	RISE (F/M)	VEL. (F/S)	REF. AREA	VENA CONT.	VALVE	TOTAL	INEPTIA	OVERALL
0.	0.	0.	0.	0.	93.300	93.300	0.	93.300
0.17	0.566	1.654	0.042	98.448	91.189	91.240	2.009	93.253
0.33	1.135	3.318	0.171	99.134	90.861	91.082	2.029	93.111
0.50	1.712	5.004	0.389	100.317	90.311	90.813	2.061	92.874
0.67	2.299	6.721	0.701	102.058	89.532	90.437	2.102	92.540
0.83	2.899	8.475	1.115	104.441	88.516	89.955	2.151	92.107
1.00	3.513	10.273	1.639	107.573	87.254	89.368	2.212	91.572
1.17	4.148	12.128	2.284	111.841	85.940	88.887	2.043	90.934
1.33	4.667	13.646	2.891	110.794	84.529	88.259	1.932	90.199
1.50	5.239	15.319	3.644	113.615	82.475	87.175	2.183	89.374
1.67	5.903	17.259	4.625	121.023	79.929	85.895	2.536	88.445
1.83	6.672	19.507	5.909	121.069	76.330	84.452	2.929	87.397
2.00	7.557	22.095	7.581	122.732	73.064	82.843	3.351	86.212
2.17	8.564	25.040	9.736	125.322	68.514	81.074	3.778	84.863
2.33	9.690	28.333	12.465	128.075	63.039	79.169	4.167	83.347
2.50	10.918	31.921	15.822	130.096	56.760	77.171	4.460	81.630
2.67	12.209	35.697	19.787	130.402	49.613	75.139	4.584	79.702
2.83	13.507	39.491	24.216	128.069	41.888	73.127	4.475	77.560
3.00	14.736	43.086	28.827	122.492	33.988	71.174	4.096	75.206
3.17	15.820	46.255	33.222	113.634	26.416	69.273	3.465	72.660
3.33	16.693	48.809	36.992	102.126	19.654	67.374	2.653	69.950
3.50	17.321	50.644	39.826	89.090	14.032	65.408	1.783	67.116
3.67	17.701	51.753	41.590	75.779	9.662	63.313	0.948	64.197
3.83	17.856	52.209	42.326	63.230	6.457	61.058	0.287	61.234
4.00	17.863	52.227	42.355	52.290	4.236	58.874	-0.588	58.257
4.50	16.657	48.702	36.830	45.469	3.683	51.194	-1.583	49.610
5.00	15.304	44.748	31.092	38.386	3.109	43.218	-1.599	41.619
5.50	13.950	40.736	25.831	31.890	2.583	35.905	-1.599	34.306
6.00	12.595	36.825	21.057	25.996	2.106	29.269	-1.599	27.670
6.50	11.240	32.863	16.770	20.704	1.677	23.310	-1.599	21.711
7.00	9.885	28.902	12.971	16.013	1.297	18.029	-1.599	16.430
7.50	8.530	24.940	9.659	11.924	0.966	13.426	-1.599	11.826
8.00	7.175	20.979	6.834	8.437	0.683	9.499	-1.599	7.900
8.50	5.820	17.017	4.497	5.552	0.450	6.250	-1.599	4.651
9.00	4.465	13.056	2.647	3.268	0.265	3.679	-1.599	2.080
9.50	3.110	9.094	1.284	1.586	0.128	1.785	-1.599	0.186
10.00	1.756	5.133	0.409	0.505	0.041	0.569	-1.599	-1.031
10.50	0.401	1.171	0.021	0.026	0.002	0.030	-1.599	-1.570
11.00	-0.843	-2.430	0.096	0.096	0.010	0.133	-1.175	-1.444
11.50	-1.472	-4.304	0.238	0.283	0.029	0.400	-0.299	-0.836
12.00	-1.417	-4.144	0.267	0.267	0.027	0.371	-2.649	-0.093

DO YOU NEED TO STORE THE OUTPUT IN A DATA FILE? Y OR N
=N

ENTER PERIN OR STOP

=PERIN

PERIN OPTION PERMITS YOU TO CHANGE ANY OF ALL INPUT VARIABLES.
AT >>>= QUE TYPE IN THE TWO LETTERS(AA,AB,ETC.) CORRESPONDING
TO THE VARIABLES YOU WISH TO CHANGE. THEN AT NEXT = QUE, ENTER
THE NUMERICAL VALUE. TO TERMINATE DATA ENTRY, TYPE A CARRIAGE
RETURN AT >>>= QUE.

```

>>>
=AB
AB-ENTER YOUR PROBLEM NAME
=EXAMPLE 2
>>>
=AC
AC-ENTER TOTAL NO. OF CALC. STEPS DESIRED
=31
>>>
=AV
AV-ENTER FIRST VALVE RATE
=1
>>>
=AV
AV-ENTER TIME VALVE STOPS MOTION(MINUTES)
=.5
>>>
=AX
AX-ENTER DURATION OF STOP(MINUTES)
=2
>>>
=AY
AY-ENTER FINAL VALVE RATE
=3
>>>
=FA
FA-ENTER 2ND OUTPUT CONTROL; 1=DO, 0=DO NOT PRINT
=0
>>>
=

```

EXAMPLE 2

CONDUIT GEOMETRY: LENGTH = 392.0 FT. WIDTH = 12.0 FT.
HEIGHT = 14.0 FT. N = 2-CULVERT OPERATION

CHAMBER GEOMETRY: LENGTH = 635.4 FT. WIDTH = 86.0 FT.

LOSS COEFFICIENTS: INTAKE 0.200
UPSTREAM CONDUIT 0.060
DOWNSTREAM CONDUIT 0.130
MANIFOLD 0.350
TOTAL(VALVE OPEN) 1.390 LOCK COEF.=0.843

ELEVATIONS: UPPER POOL 262.30
LOWER POOL 169.50
CULVERT ROOF 123.00

VALVE OPENS AT 1.00-MIN. RATE FOR 0.50 MINUTES
VALVE HOLDS FOR 2.00-MIN. AT 5.32 FT.
THEN OPENS AT 3.00-MIN. RATE TO FULL OPEN
TOTAL VALVE TIME = 4.17-MIN. (N = 26)

ACC.VEL. ERROR TO I = 31 IS 0.01400
ACC.VEL. ERROR TO I = 31 IS 0.01400
LOCK OPERATION IS NOT COMPLETE
LOCK DOES NOT COMPLETE OVERTRAVEL

VALVE PARAMETERS					ELEVATIONS (FT-DATUM)				
TIME OPEN.	CONT.	LOSS	TOTAL		LOCK	US VALVE	PIEZ. HD	DS VALVE	
(M) RATIO	COEF.	COEF.	INFLOW		CHAMBER	WELL	VALVE	WELL	
			CFS					CAV. PAP.	
0.	0.	0.80	10000.00	0.	169.50	262.80	169.50	169.50 9.99	
0.17	0.11	0.78	127.64	2190.	169.69	261.97	166.66	170.25 0.88	
0.33	0.23	0.70	29.23	4453.	170.25	259.36	157.58	172.57 0.71	
0.50	0.33	0.65	9.64	7548.	171.27	252.93	133.88	177.93 0.39	
0.67	0.38	0.65	9.64	7737.	172.56	252.43	127.37	179.56 0.32	
0.83	0.38	0.65	9.64	7699.	173.87	252.53	128.69	180.80 0.33	
1.00	0.38	0.65	9.64	7644.	175.17	252.67	130.60	182.01 0.35	
1.17	0.38	0.65	9.64	7588.	176.47	252.82	132.54	183.20 0.37	
1.33	0.38	0.65	9.64	7531.	177.75	252.97	134.47	184.38 0.40	
1.50	0.38	0.65	9.64	7475.	179.02	253.12	136.38	185.55 0.42	
1.67	0.38	0.65	9.64	7418.	180.29	253.26	138.29	186.72 0.44	
1.83	0.38	0.65	9.64	7362.	181.54	253.41	140.17	187.88 0.46	
2.00	0.38	0.65	9.64	7305.	182.78	253.55	142.05	189.02 0.48	
2.17	0.38	0.65	9.64	7249.	184.02	253.69	143.90	190.16 0.51	
2.33	0.38	0.65	9.64	7193.	185.24	253.83	145.75	191.29 0.53	
2.50	0.38	0.65	9.64	7040.	186.45	254.21	150.67	192.24 0.60	
2.67	0.44	0.66	6.32	8200.	187.74	251.15	150.01	195.60 0.59	
2.83	0.50	0.67	4.03	9645.	189.26	246.68	146.19	200.13 0.53	
3.00	0.56	0.69	2.51	11241.	191.03	240.90	143.75	205.80 0.50	
3.17	0.63	0.72	1.52	12873.	193.07	234.08	144.83	212.45 0.51	
3.33	0.70	0.74	0.91	14388.	195.39	226.93	150.73	219.59 0.60	
3.50	0.77	0.78	0.53	15629.	197.93	220.47	161.31	226.49 0.77	
3.67	0.85	0.82	0.31	16501.	200.66	215.61	174.88	232.49 1.08	
3.83	0.92	0.86	0.13	16992.	203.50	212.76	189.14	237.25 1.53	
4.00	1.00	0.90	0.10	17201.	206.40	211.52	201.98	240.99 2.16	
4.17	1.00	0.90	0.10	16922.	209.29	213.18	203.94	242.77 2.27	
4.67	1.00	0.90	0.10	15647.	217.59	220.37	212.47	246.21 2.86	

DO YOU NEED TO STORE THE OUTPUT IN A DATA FILE? Y OR N
=Y

ENTER A 5-LETTER FILE NAME

=DLK1

YOUR OUTPUT VALUES ARE STORED IN FILE DLK1

ENTER REPLY OR STOP

=STOP

REF: ER 1110-1-10 - ENGINEERING AND DESIGN - Engineering and Computer
Program Library Standards and Documentation, Appendix C

PART III: FILE DOCUMENTATION

1. REVISION LOG: N/A
2. TITLE: H5320 - Lock Filling and Emptying - Symmetrical Systems
3. SOURCE PROGRAM LISTINGS: See pages 41-52
4. NUMERICAL AND LOGICAL ANALYSIS: A finite difference scheme is used to determine the flow rate through the culverts and water surface elevation in the chamber during a lock operation.
5. SUBROUTINES NOT DOCUMENTED IN ABSTRACT: None
6. MISCELLANEOUS: The program is part of the CORPS computer system. CORPS is an acronym standing for Conversationally Oriented Real-Time Program-Generating System. The program is now operational on the WES G635, Vicksburg, MS; HIS 66/80, Macon, GA, and Boeing CDC, Seattle, WA. The source listing on page 41 contains the first line run command and brief for H5320. This first line run command runs the binary H5320B of the source listing on pages 42-52 (Fortran source of H5320) and attaches the WESLIB routines HACCT and RERUN.

H5320

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H5320

0001*#PIN WESLIB/H5320B, P WESLIB/PERIN, P WESLIB/HACCT, R
0300 03NO BRIEF
0999*06FINISH

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H5320S

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00001*#RUN *:=WESLIB/H5320B,R(NOGO)
10000 CHARACTER*5 HFILE
10010 COMMON LQZ,LQX
10020 HFILE=5HH5320
10030 LQZ=1;LQX=1
10040 PRINT 10
10050 10 FORMAT(/'H5320 - LOCK FILLING AND EMPTYING-SYMMETRICAL SYSTE
10060 &MS'//)
10070 15000 CONTINUE
10080 CALL HACCT(HFILE)
10090 IF(LQZ.EQ.1) CALL H5320($16000)
10100 GO TO(20,30),LQZ
10110 30 CALL DATAF($16000)
10120 CALL MAIN1($16000)
10130 PRINT," "
10140 20 LQZ=2
10150 CHARACTER ZZZZZZ*2
10160 16000 PRINT, "ENTER PERIN OP STOP"
10170 READ 16001, ZZZZZZ
10180 16001 FORMAT(A2)
10190 IF(ZZZZZZ.EQ.2HRE) GO TO 15000
10200 IF(ZZZZZZ.EQ.2HST) GO TO 20000
10210 PRINT,"EPPOP *** PETYPE"
10220 GO TO 16000
10230 20000 STOP;END
20000 SUBROUTINE H5320(*)
20010 COMMON LQZ,LQX,XBB(201),TYPE,RUN,XN,ZU,ZL,ZP,XL1,XL2,XL3,XL4,XL5,
20020 XK1,XK2,XK3,XK4,DTS,M,I VALU,N,BB1,AAB,TU1,T1,TLAG,TU2,AAC,SAG,IPR
20030 IN1,IPPIN2,IDE1,IDE2,NSTART,KK,I VAL1,I VAL2,LINE(201)
20040 DIMENSION XT(201),XKV(201),XCC(201),Q(201),PP(201),Z(201),ZIW(201)
20050 ZV(201),ZDV(201),V(201),VH(201),HL1(201),HL2(201),HLV(201),HL3(20
20060 &1),HL4(201),HLT(201),HI(201),H(201),XK(201),CI(201),VHVC(201)
20070 CHARACTER RUN*35,AAA*1,AAB*8,AAC*10,AAD*8,AAE*10,CFILE*25
20080 DATA B,C,D,E,F,C1(1),XKV(1)/2.2,3.2,.65,.8,.9,9.99,10000.0/
20090 KK=0;I VAL1=0;I VAL2=0
20100 10090 FORMAT(3X,3F8.3/3X,5F8.3/3X,4F8.3/3X,F5.1,2I4,5I2)
20110 10100 FORMAT(3X,2F4.0,A35)
20120 10110 FORMAT(3X,10F6.3)
20130 10120 FORMAT("CONDUIT GEOMETRY: LENGTH = ",F7.1," FT.  WIDTH = ",
20140 F5.1," FT.",/,13X,"HEIGHT=",F5.1," FT.  N=",12,
20150 &"-CULVERT OPERATION)",/,,"CHAMBER GEOMETRY:",
20160 &" LENGTH = ",F6.1," FT.  WIDTH = ",F5.1," FT.",/,,"LOSS ",
20170 &"COEFFICIENT: INTAKE",F7.3,/,9X,"UPSTREAM CONDUIT",F7.3,/,
20180 &7X,"DOWNSTREAM CONDUIT",F7.3,/,17X,"MANIFOLD",F7.3,/,3X,"TOTAL
20190 &(VALVE OPEN)",F7.3,"  LOCK COEF.",F5.3,/,
20200 &"ELEVATIONS: UPPER POOL",F7.2,/,13X,"LOWER POOL",
20210 &F7.2,/,11X,"CULVERT POOF",F7.2)
20220 10210 FORMAT(/,"VALVE OPENS AT",F7.2,"-MIN. RATE FOR",F7.2,
20230 &" MINUTES")
20240 10230 FORMAT("VALVE HOLDS FOR",F6.2,"-MIN. AT",F6.2,"FT.",/,

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H5320S CONT.

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20250&"THEN OPENS AT",F6.2,"-MIN. PATE TO FILL OPEN",/,
20260&"TOTAL VALVE TIME =",F6.2,"-MIN. (N=",13,")"///)
20270 10260 FORMAT(//,"SPECIAL VALVING TIME=",F7.2,"-MIN."///)
20280 10270 FORMAT("EXTREME ELEVATION AT TIME =",
20290&F6.2," MINUTES",//,"MAX COMPUTED OVERTRAVEL =",F5.2," FT.")
20300 10290 FORMAT(//,6X,"VALVE PARAMETEPS",15X,"ELEVATIONS (FT-DATIM)"/
20310&"TIME OPEN. CONT. LOSS TOTAL LOCK US VALVE PIEZ.HD DS",
20320&" VALVE"/" (M) RATIO COEF. COEF. INFLOW CHAMBER WELL"
20330&," VALVE WELL",//,27X,"CFS",33X,"CAV.PAR.")
20340 10330 FORMAT(F6.2,2F5.2,F9.2,F7.0,4F8.2,F5.2)
20350 10340 FORMAT(9X,"RATE",10X,"VEL HDS(F)",10X,"DIFFEPENTIAL HDS(F)"/
20360&9X,"RISE VEL. REF. VENA VALVE TOTAL INERTIA OVERALL"/
20370&8X,"(F/M) (F/S) AREA CONT.",11X,"LOSS"/)
20380 10370 FORMAT(F6.2,3F7.3,3F8.3,F7.3,F8.3)
20390 10380 FORMAT(//,"LOCK EMPTIES TO LOWER POOL IN ",F5.2," MINUTES")
20400 10390 FORMAT(//,"LOCK FILLS TO UPPER POOL IN ",F5.2," MINUTES")
20410 10400 FORMAT("ACC.VEL. ERROR TO I=",13," IS",F10.5)
20420 10410 FORMAT(//)
20430 10420 FORMAT(A1,A8,A1)
20440 10430 FORMAT(I3,3F6.2,F9.2,F7.0,4F7.2,4F6.2,5F7.2)
20450 NSTART=0
20460 PRINT,"DO YOU HAVE A PERMANENT DATA FILE?Y=YES;N=NO"
20470 READ,AAA
20480 IF(AAA.EQ.1)GO TO 10540
20490 PRINT,"WE WILL HELP YOU SET UP YOUR DATA FILE"
20500 PRINT,"YOU MUST SUPPLY 29 DATA ITEMS AND A FILE NAME"
20510 PRINT,"ENTER YOUR NEW 5-LETTER FILE NAME"
20520 READ,AAB
20530 CALL DATAF($22275)
20540 GO TO 10610
20550 10540 PRINT,"ENTER YOUR 5-LETTER FILE NAME"
20560 NSTART=1
20570 10560 READ,AAB
20575 IF(AAB.EQ.5)STOP ) RETURN 1
20580 GO TO 10610
20590 10580 PRINT 10590,AAB
20600 10590 FORMAT("NO FILE ",A8,". ENTER FILE NAME OP STOP")
20610 GO TO 10560
20620 10610 ENCODE(AAC,10420) "/" ,AAB,";"
20630 ENTPY MAIN(*)
20640 10630 CONTINUE
20650 CALL ATTACH(1,AAC,3,0,ISTAT,)
20660 CALL TEST(ISTAT,IDEC)
20670 GO TO(10670,10580,941,10530),IDEC
20680 10670 CONTINUE;KK=1
20690 READ(1,10100) TYPE,XN,RIN
20700 READ(1,10090) Z",ZL,ZR,XL1,XL2,XL3,XL4,XL5,
20710&XK1,XK2,XK3,XK4,DTS,M,N,IVALV,IPRIN1,IPPIN2,IDEL1,IDEL2
20720 IF(ABS(TYPE).LT.0.99.OP.ABS(TYPE).GT.1.01)GO TO 294
20730 IF(IVALV.EQ.2)GO TO 10750

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H5320S CONT.

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20740 READ(1,10110,END=10770)(XBB(I),I=1,N)
20750 GO TO 10770
20760 10750 READ(1,10110,END=10760)SAG,TV1,T1,TLAG,TV2
20770 10760 CALL VAL2(SAG,TV1,T1,TLAG,TV2,DTS,N,BB1,XBB)
20780 10770 IF(NSTART.EQ.0)GO TO 10320
20790 PRINT,"DO YOU WISH TO CHANGE ANY DATA BEFORE YOU START? YES OR NO?"
20800 "
20810 READ,AAA;IF(AAA.EQ.1HY) XK=1
20820 IF(AAA.EQ.1HY) CALL RUN1($10630)
20830 10320 CONTINUE
20840 NSTART=0
20850 DTM=DTS/60.0;T3=(N-1)*DTM;NC=XN;AR=(XN*XL2*XL3)/(XL4*XL5)
20860 DO 10930 I=2,M+1
20870 IF(I.GT.N)XBB(I)=XBB(I-1)
20880 XT(I)=XT(I-1)+DTM
20890 IF(XBB(I).LE.0.2) XKV(I)=(10.0**((B-.2*C)))*(0.04/XBB(I)**2)
20900 IF(XBB(I).GE.0.2) XKV(I)=10.0**((B-C*XBB(I)))
20910 IF(XBB(I).LE.0.3) XCC(I)=D*(E-D)*COS(3.141593*(XBB(I)/0.60))
20920 IF(XBB(I).GE.0.3) XCC(I)=F*(F-D)*COS(((XBB(I)-.3)*3.141593)/1.4)
20930 XK(I)=XK1+XK2+XK3+XK4+XKV(I)
20940 10930 CONTINUE
20950 XKT=XK1+XK2+XK3+XK4+10.0**((B-C))
20960 XKC=SQRT(1/XKT);PRINT 10950,RUN;10950 FORMAT(/A35//)
20970 IF(1PRINT.EQ.1)PRINT 10120,XL1,XL2,XL3,NC,XL4,XL5,
20980,XK1,XK2,XK3,XK4,XKT,XKC,ZU,ZL,ZR
20990 BB2=XL3*BB1
21000 IF(IVALV.EQ.2)PRINT 10210,TV1,T1
21010 IF(IVALV.EQ.2.AND.T1.LT.TV1)PRINT 10230,TLAG,BB2,TV2,T3,N
21020 IF(IVALV.EQ.1)PRINT 10260,T3
21030 SET INITIAL CONDITIONS
21040 IF(TYPE)11040,11060,11060
21050 11040 Z(1)=ZU;ZPEF=ZL;ZDW(1)=ZU
21060 GO TO 11070
21070 11060 Z(1)=ZL;ZPEF=ZU;ZDW(1)=ZL
21080 11070 CONTINUE
21090 XCC(1)=E;M1=M;M2=M;ZUW(1)=ZU;ZOT=0.0;ZV(1)=ZL
21100 M3=M
21110 H(1)=ZU-ZL;HLV(1)=H(1);HLT(1)=H(1)
21120 STAPT NUMEPICAL INTEGRATION
21130 DO 11270 I=1,M-1
21140 V(I+1)=PPED(Z(I),V(I),XK(I+1),TYPE,ZPEF,AP,DTS,XL1)
21150 Z(I+1)=ZNEW(Z(I),V(I),V(I+1),AP,DTS,TYPE)
21160 IF(ABS(XL1*(V(I+1)-V(I))).GE..5*XK(I+1)*DTS*V(I+1)**2)M3=I-1
21170 IF(I.GT.M3.OR.I.GT.M1)GO TO 11250
21180 DO 11230 J=1,10
21190 V(I+2)=PPED(Z(I+1),V(I+1),XK(I+2),TYPE,ZPEF,AP,DTS,XL1)
21200 V(I+1)=COPR(Z(I),V(I),XK(I+1),V(I+2),TYPE,ZPEF,AP,DTS,XL1)
21210 ZCHEC=ZNEW(Z(I),V(I),V(I+1),AP,DTS,TYPE)
21220 IF(ABS(ZCHEC-Z(I+1)).LE.0.0001)GO TO 11240
21230 Z(I+1)=ZCHEC

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H5320S CONT.

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21240 11230 CONTINUE
21250 11240 Z(I+1)=ZCHEC
21260 11250 IF(M2.EQ.M.AND.V(I+1).LT.0.0)M2=1
21270 IF(M1.EQ.M.AND.TYPE*(ZREF-Z(I+1)).LE.0.0) M1=1
21280 11270 CONTINUE
21290 ERROR=0.0
21300 PRINT 10410
21310 DO 11350 I=2,M2
21320 YY=CORR(Z(I-1),V(I-1),XK(I),V(I+1),TYPE,ZREF,AR,DTS,XL1)
21330 ERROR=(YY-V(I))*2+ERROR
21340 IF(I.EQ.M1)PRINT 10400,I,ERROR
21350 IF(I.EQ.M2)PRINT 10400,I,ERROR
21360 11350 CONTINUE
21370C END OF DIFF.EQNS.
21380 DO 11690 I=2,M
21390 VH(I)=(V(I)**2)/64.4
21400 Q(I)=V(I)*XL2*XL3*XN
21410 PR(I)=(Q(I)*60.0)/(XL4*XL5)
21420 HI(I)=XL1*(V(I+1)-V(I-1))/(64.4*DTS)
21430 HL1(I)=XK1*VH(I)
21440 HL2(I)=XK2*VH(I)
21450 HLV(I)=XKV(I)*VH(I)
21460 HL3(I)=XK3*VH(I)
21470 HL4(I)=XK4*VH(I)
21480 HLT(I)=XK(I)*VH(I)
21490 H(I)=TYPE*(ZREF-Z(I))
21500 IF(V(I).GE.0.0)VHVC(I)=VH(I)/(XCC(I)*XBB(I))*2
21510 IF(V(I).LT.0.0)VHVC(I)=VH(I)
21520 IF(TYPE)11590,11590,11520
21530 11520 IF(V(I).GT.0.0)ZUW(I)=ZU-(1.0+XK1+XK2)*VH(I)
21540 IF(V(I).LE.0.0)ZUW(I)=ZU-(1.0-XK1-XK2)*VH(I)
21550 IF(V(I).GE.0.0)ZDW(I)=Z(I)+XK4*VH(I)
21560 IF(V(I).LT.0.0)ZDW(I)=Z(I)-XK4*VH(I)
21570 IF(V(I).GT.0.0)ZV(I)=ZUW(I)+VH(I)-VHVC(I)
21580 IF(V(I).LE.0.0)ZV(I)=ZUW(I)-VHVC(I)
21590 GO TO 11640
21600 11590 ZUW(I)=ZU
21610 IF(V(I).GE.0.0)ZDW(I)=Z(I)-(1.0+XK1+XK2)*VH(I)
21620 IF(V(I).LT.0.0)ZDW(I)=Z(I)-(1.0-XK1-XK2)*VH(I)
21630 IF(V(I).GE.0.0)ZV(I)=ZDW(I)+VH(I)-VHVC(I)
21640 IF(V(I).LT.0.0)ZV(I)=ZDW(I)-VHVC(I)
21650 11640 CONTINUE
21660 IF(V(I).LE.0.0)CI(I)=9.99
21670 IF(V(I).GT.0.0)CI(I)=(ZV(I)-ZP+XL3*(1.-XCC(I)*XBB(I)))/VHVC(I)
21680 33.0/VHVC(I)
21690 IF(CI(I).GE.10.0)CI(I)=9.99
21700 11690 CONTINUE
21710 XTX=XT(M1)+DTM*(ZREF-Z(M1))/(Z(M1+1)-Z(M1))
21720 XTM=XT(M2)
21730 ZOT=Z(M2)-ZREF

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H5320S CONT.

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21740 IF(M1.EQ.M)PRINT,"LOCK OPERATION IS NOT COMPLETE"
21750 IF(M2.EQ.M)PRINT,"LOCK DOES NOT COMPLETE OVERTRAVEL"
21760 IF(M1.LT.M.AND.TYPE.GT.0.0)PRINT 10390,XTX
21770 IF(M1.LT.M.AND.TYPE.LT.0.0)PRINT 10380,XTX
21780 IF(M2.LT.M)PRINT 10270,XTM,ZOT
21790 PRINT 10290
21800 PRINT 10330,(XT(I),XEB(I),XCC(I),XKV(I),Q(I),Z(I),ZUV(I),
21810&ZV(I),ZDW(I),CI(I),I=1,N,IDEL1)
21820 PRINT 10330,(XT(I),XBB(I),XCC(I),XKV(I),Q(I),Z(I),ZUV(I),
21830&ZV(I),ZDW(I),CI(I),I=N+1,IDEL2,M,IDEL2)
21840 IF (IPRIN2)11900,11900,11840
21850 11840 CONTINUE
21860 PRINT 10340
21870 PRINT 10370,(XT(I),RR(I),V(I),WH(I),WHVC(I),HLV(I),HLT(I),
21880&HI(I),H(I),I=1,N,IDEL1)
21890 PRINT 10370,(XT(I),RR(I),V(I),WH(I),WHVC(I),HLV(I),HLT(I),
21900&HI(I),H(I),I=N+1,IDEL2,M,IDEL2)
21910 11900 CONTINUE
21920 PRINT,"DO YOU NEED TO STORE THE OUTPUT IN A DATA FILE?Y OR N"
21930 READ,AAA
21940 IF(AAA.EQ.1HN)GO TO 320
21950 PRINT,"ENTER A 5-LETTER FILE NAME"
21960 READ,AAD
21970 LINE(I)=100
21980 DO 11980 I=2,M
21990 11980 LINE(I)=LINE(I-1)+2
22000 ENCODE(AAE,10420)"/",AAD,";"
22010 ENCODE(CFILE,59) "CF,/",AAD,"",B/1,35/,R,W#"
22020 CALL ATTACH(2,AAE,3,0,1STAT,)
22030 CALL TEST(1STAT,1DEC)
22040 GO TO(172,173,175,175,175),1DEC
22050 173 CALL ACCESS(CFILE,$175)
22060 172 CONTINUE
22070 CALL ATTACH(2,AAE,3,,)
22080 CALL HEADER(M)
22090 DO 12075 I=1,M;12075 XKV(I)=ALOG10(XKV(I))
22100 WRITE(2,10430) (LINE(I),XT(I),XEB(I),XCC(I),XKV(I),Q(I),Z(I),
22110&ZUV(I),ZV(I),ZDW(I),CI(I),RP(I),V(I),WH(I),WHVC(I),HLV(I),
22120&HLT(I),HI(I),H(I),I=1,M)
22130 61 CALL DETACH(2,,)
22140 PRINT 160,AAD
22150 160 FORMAT("YOUR OUTPUT VALUES ARE STORED IN FILE ",A8)
22160 59 FORMAT(A4,A8,A13)
22170 GO TO 320
22180 175 PRINT,"FILE PROBLEM;ILLEGAL CHAP;BUSY;OR SYSTEM PROBLEM"
22190 PRINT,"OUTPUT VALUES NOT SAVED AS REQUESTED"
22200 320 CONTINUE
22210 GO TO 293
22220 294 PRINT,"PROGRAMMED STOP;TYPE NOT EQUAL 1 OR -1";RETURN 1
22230 941 PRINT 946,1STAT

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H5320S CONT.

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22240 946 FORMAT("FILE PROBLEM. CALL FTS 542-2403 AND GIVE THIS NUMB
22250&EP ",012)
22260 293 CONTINUE
22270 CALL DETACH(1,,);RETURN
22275 22275 RETURN 1
22280 END
22290 FUNCTION PRED (ZST,VST,XKF,TYPE,ZREF,AR,DTS,XL1)
22300 XC=(64.4/XKF)*(TYPE*(ZREF-ZST)-VST*(.5*AR*DTS-XL1/(32.2*DTS)))
22310 XB=(64.4/XKF)*(.5*AR*DTS+XL1/(32.2*DTS))
22320 IF(XC.GE.0.0) PRED=-.5*XB+.5*SQR(XB**2+4.*XC)
22330 IF(XC.LT.0.0) PRED=.5*XB-.5*SQR(XB**2-4.*XC)
22340 RETURN;END
22350 FUNCTION CORR (ZST,VST,XKF,VAH,TYPE,ZREF,AR,DTS,XL1)
22360 XC=(64.4/XKF)*(TYPE*(ZREF-ZST)-.5*VST*AR*DTS-XL1*(VAH-VST)/
22370(64.4*DTS))
22380 XB=32.2*AR*DTS/XKF
22390 IF(XC.GE.0.0) COPP=-.5*XB+.5*SQR(XB**2+4.*XC)
22400 IF(XC.LT.0.0) COPR=.5*XB-.5*SQR(XB**2-4.*XC)
22410 RETURN;END
22420 FUNCTION ZNEW (ZST,VST,VF,AR,DTS,TYPE)
22430 ZNEW=ZST+TYPE*.5*AR*DTS*(VST+VF)
22440 RETURN;END
22450 SUBROUTINE TEST(ISTAT,IDECL)
22460 DIMENSION ITEST(5)
22470 DATA ITEST/000,005,037,004,034/
22480 IDECL=3
22490 ISTAT=FLD(6,6,ISTAT)
22500 IF(ISTAT.EQ.ITEST(3).OR.ISTAT.EQ.ITEST(1)) IDECL=1
22510 IF(ISTAT.EQ.ITEST(2)) IDECL=2
22520 IF(ISTAT.EQ.ITEST(4)) IDECL=4
22530 IF(ISTAT.EQ.ITEST(5)) IDECL=5
22540 RETURN;END
22550 SUBROUTINE VAL2(A,TV1,T1,TLAG,TV2,DTS,N,BB1,XBB)
22560 DIMENSION XT(201),XBB(201)
22570 T2S=0.0;BB1=0.0;DTM=DTS/60.0;XT(1)=0.0;PI=3.141593
22580 IF(TV1-DTM)182,186,186
22590 182 PRINT,"YOUR 1ST VALVE RATE IS LESS THAN ONE TIME STEP"
22600 PRINT,"ENTER VALVE OPENING RATIO AT END OF 1ST TIME STEP"
22610 READ,BB1
22620 T1=0.0
22630 186 CONTINUE
22640 IF(TV1.GE.DTM)BB1=T1/TV1-A*SIN(PI*T1/TV1)
22650 T2S=BB1*TV2
22660 DO 214 J=1,6
22670 T2N=T2S+(TV2*BB1-T2S+A*TV2*SIN(PI*T2S/TV2))/
22680(1.0-A*PI*COS(PI*T2S/TV2))
22690 IF(ABS(T2N/T2S-1.0).LE.0.0001) GO TO 215
22700 214 T2S=T2N
22710 215 CONTINUE
22720 T2=T1+TLAG

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22730 T3=T2-T2S+TV2
22740 N=T3/DTM+2
22750 DO 52 I=2,N
22760 XT(I)=XT(I-1)+DTM
22770 IF(XT(I).LE.T1)YBB(I)=XT(I)/TV1-A*SIN(PI*XT(I)/TV1)
22780 IF(XT(I).GT.T1.AND.XT(I).LE.T2)YBB(I)=EB1
22790 IF(XT(I).GT.T2)YBB(I)=(XT(I)-T2+T2S)/TV2-A*SIN(PI*(XT(I)-T2+T2S)
22800 &/TV2)
22810 52 CONTINUE
22820 IF(YBB(N).GT.1.0)YBB(N)=1.0
22830 RETURN;END
22840 SUBROUTINE DATA(*)
22850 COMMON LQZ,LQY,YBB(201),TYPE,PUN,XN,ZU,ZL,ZP,XL1,XL2,XL3,XL4,XL5,
22860 &XK1,XK2,XK3,XK4,ETS,M,IVALU,N,EB1,AAB,TV1,T1,TLG,TV2,AAC,SAG,IPR
22870 &IN1,IPIN2,IDEL1,IDEL2,NSTART,XK,IVAL1,IVAL2,LINE(201)
22880 CHARACTER PUN*35,AAB*8,AAC*10,CFILE*24
22890 IF(LQY.EQ.3) GO TO 11520
22900 ENTRY PUN1(*)
22910 IF(LQZ.EQ.2) GO TO 11520
22920 CALL PRINTT
22930 IF(NSTART.EQ.0) GO TO 11520
22940 LQZ=2;PEWIND 1
22950 11520 KKK=29
22960 GO TO(111,112),LQZ
22970 112 CALL PEPUN(KKK,LQY,JKL)
22980 GO TO(1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,
22990 &24,25,26,27,28,29,30),JKL
23000 111 CONTINUE
23010 GO TO(1,112),LQZ
23020 1 PRINT,"AA-ENTER 1=FULL;OP -1=EMPTY;OP 0=TERMINATE NOW"
23030 READ,TYPE
23040 IF(ABS(TYPE).LT.0.99)GO TO 174
23050 GO TO(2,112),LQZ
23060 2 PRINT,"AD-ENTER YOUR PROBLEM NAME"
23070 READ 33,PUN
23080 33 FORMAT(A35)
23090 GO TO(3,112),LQZ
23100 3 PRINT,"AC-ENTER 1=1-CILV;OP 2=2-CILV. OPERATION"
23110 READ,XN
23120 GO TO(4,112),LQZ
23130 4 PRINT,"AD-ENTER UPPER POOL ELEVATION"
23140 READ,ZU
23150 GO TO(5,112),LQZ
23160 5 PRINT,"AE-ENTER LOWER POOL ELEVATION"
23170 READ,ZL
23180 GO TO(6,112),LQZ
23190 6 PRINT,"AF-ENTER CILV. POOF ELEVATION"
23200 READ,ZP
23210 GO TO(7,112),LQZ
23220 7 PRINT,"AG-ENTER CILV. LENGTH"

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23230 READ,YL1
23240 GO TO(3,112),LQZ
23250 3 PRINT,"AH-ENTER C'LV. WIDTH"
23260 READ,YL2
23270 GO TO(9,112),LQZ
23280 9 PRINT,"AI-ENTER C'LV. HEIGHT"
23290 READ,YL3
23300 GO TO(10,112),LQZ
23310 10 PRINT,"AJ-ENTER CHAMBER LENGTH"
23320 READ,YL4
23330 GO TO(11,112),LQZ
23340 11 PRINT,"AK-ENTER CHAMBER WIDTH"
23350 READ,YL5
23360 GO TO(12,112),LQZ
23370 12 PRINT,"AL-ENTER C'LV. INTAKE LOSS COEF."
23380 READ,YK1
23390 GO TO(13,112),LQZ
23400 13 PRINT,"AM-ENTER U-S C'LV. LOSS COEF."
23410 READ,YK2
23420 GO TO(14,112),LQZ
23430 14 PRINT,"AN-ENTER D-S C'LV. LOSS COEF."
23440 READ,YK3
23450 GO TO(15,112),LQZ
23460 15 PRINT,"AO-ENTER C'LV. EXIT LOSS COEF."
23470 READ,YK4
23480 GO TO(16,112),LQZ
23490 16 PRINT,"AP-ENTER TIME STEP IN SECONDS"
23500 READ,DTS
23510 GO TO(17,112),LQZ
23520 17 PRINT,"AQ-ENTER TOTAL NO. OF CALC. STEPS DESIRED"
23530 READ,M
23540 GO TO(18,112),LQZ
23550 18 PRINT,"AR-ENTER TYPE OF VALVING(1 OF 2) SEE TABLE)"
23560 READ,I'VAL"
23570 IF(I'VAL".EQ.2) GO TO 50
23580 GO TO(19,11556),LQZ
23590 11556 LQZ=1
23600 19 PRINT,"AS-ENTER NO. OF RATIOS TO BE ENTERED"
23610 READ,N
23620 GO TO(20,112),LQZ
23630 20 PRINT,"AT-ENTER VALVE RATIOS(SEP. BY COMMAS)"
23640 READ,(YBB(I),I=1,N)
23650 IF(I'VAL1.EQ.0.AND.I'VAL2.EQ.1) LQZ=2
23660 I'VAL1=1
23670 IF(KK.EQ.1) LQZ=2
23680 GO TO 60
23690 50 GO TO(21,11591),LQZ
23700 11591 LQZ=1
23710 21 PRINT,"AU-ENTER VALVE SAG"
23720 READ,SAG
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H5320S CONT.

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23730 GO TO(22,112),LQZ
23740 22 PRINT,"AV-ENTER FIRST VALVE RATE"
23750 READ,TV1
23760 GO TO(23,112),LQZ
23770 23 PRINT,"AV-ENTER TIME VALVE STOPS MOTION(MINUTES)"
23780 READ,T1
23790 GO TO(24,112),LQZ
23800 24 PRINT,"AY-ENTER DURATION OF STOP(MINUTES)"
23810 READ,TLAG
23820 GO TO(25,112),LQZ
23830 25 PRINT,"AY-ENTER FINAL VALVE RATE"
23840 READ,TV2
23850 IF(I'VAL1.EQ.1.AND.I'VAL2.EQ.0) LQZ=2
23860 I'VAL2=1
23870 IF(KK.EQ.1) LQZ=2
23880 60 CONTINUE
23890 GO TO(26,112),LQZ
23900 26 PRINT,"AZ-ENTER 1ST OUTPUT CONTROL; 1=DO, 0=DO NOT PRINT"
23910 READ,IPPIN1
23920 GO TO(27,112),LQZ
23930 27 PRINT,"BA-ENTER 2ND OUTPUT CONTROL; 1=DO, 0=DO NOT PRINT"
23940 READ,IPPIN2
23950 GO TO(28,112),LQZ
23960 28 PRINT,"BB-ENTER FIRST OUTPUT RATE; 1=EVERY VALUE"
23970 READ,IDE1
23980 GO TO(29,112),LQZ
23990 29 PRINT,"BC-ENTER FINAL OUTPUT RATE; 2=EV. 2ND VALUE"
24000 READ,IDE2
24010 GO TO(30,112),LQZ
24020 30 CONTINUE
24030 LINE(1)=100
24040 DO 54 J=2,N/10+6
24050 54 LINE(J)=LINE(J-1)+2
24060 ENCODE(AAC,55)"/",AAB,";"
24070 DO 62 J=N+1,N+10
24080 62 XEB(J)=XEB(J-1)
24090 ENCODE(CFILE,59)"CF,/",AAB,".B/1,3/,P,W#"
24100 CALL ATTACH(1,AAC,3,0,1STAT,)
24110 CALL TEST(1STAT,1DEC)
24120 GO TO(172,173,175,175,175),1DEC
24130 173 CALL ACCESS(CFILE,1175)
24140 172 CONTINUE
24150 CALL ATTACH(1,AAC,3,,)
24160 WRITE(1,56)LINE(1),TYPE,XN,PIN,LINE(2),Z1,ZL,ZP,LINE(3),
24170 XL1,XL2,XL3,XL4,XL5,LINE(4),XK1,XK2,XK3,XK4,LINE(5),DTS,
24180 M,N,I'VAL,IPPIN1,IPPIN2,IDE1,IDE2
24190 DO 58 J=1,N/10+1
24200 IF(I'VAL.EQ.2)WRITE(1,57)LINE(6),SAG,TV1,T1,TLAG,TV2
24210 IF(I'VAL.EQ.2)GO TO 61
24220 58 WRITE(1,57)LINE(J+5),(XEB(1),1=10*J-9,10*J)

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H53205 CONT.

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24230 61 CALL DETACH(1,,)
24240 55 FORMAT(A1,A8,A1)
24250 59 FORMAT(A4,A8,A12)
24260 56 FORMAT(13,2F4.0,A35,/,13,3F8.3,/,13,5F8.3,/,13,4F8.3,/,
24270&13,F5.1,2I4,5I2)
24280 57 FORMAT(13,10F6.3)
24290 GO TO 200
24300 174 PRINT,"PROGRAMMED STOP;TYPE=0;REVIEW YOUR DATA"; RETURN 1
24310 175 PRINTFILE PROBLEMS;ILLEGAL CHARACTER;BUSY;OF SYSTEM PROB."
24320 200 IF(NSTART.EQ.1) GO TO 1192
24330 RETURN
24340 1192 NSTART=0;LOZ=1;RETURN 1;END
24350 SUBROUTINE PRINTT
24360 CHARACTER AAA*1
24370 PRINT,"SHOULD I PRINT A TABLE OF INPUT CODES?Y=YES;N=NO"
24380 READ,AAA
24390 IF(AAA.EQ.1HN)GO TO 4
24400 PRINT 2
24410 2 FORMAT("CODE VARIABLE",17X,"DESCRIPTION"/
24420&"AA TYPE",3X,"1=FULL;-1=EMPTY;0=TERMINATE RUN"/
24430&"AB RUN",4X,"PROBLEM NAME(35 SPACES AVAILABLE)"/
24440&"AC XN",5X,"1=ONE C/LV.;2=TWO C/LV.EPT OPERATION"/
24450&"AD Z1",5X,"UPPER POOL ELEV.(FT-DATIM)"/
24460&"AE ZL",5X,"LOWER POOL ELEV.(FT-DATIM)"/
24470&"AF ZP",5X,"C/LV. POOF ELEV.(FT-DATIM) AT VALVE"/
24480&"AG XL1",4X,"C/LV. LENGTH(FT)"/
24490&"AH XL2",4X,"C/LV. WIDTH(FT)"/
24500&"AI XL3",4X,"C/LV. HEIGHT(FT)"/
24510&"AJ XL4",4X,"CHAMBER LENGTH(FT)"/
24520&)
24530 PRINT 3
24540 3 FORMAT(
24550&"AX XL5",4X,"CHAMBER WIDTH(FT)"/
24560&"AL XK1",4X,"INTAKE LOSS COEF."/
24570&"AM XK2",4X,""-S CONDUIT LOSS COEF."/
24580&"AN XK3",4X,""-S CONDUIT LOSS COEF."/
24590&"AO XK4",4X,"EXIT LOSS COEF."/
24600&/"NOTE:LOSS COEF.=SQAPE ROOT OF 1/(XK1+XK2+XK3+XK4+0.1)"/
24610&"AP DTS",4X,"TIME STEP(SEC.) FOR CALCULATIONS"/
24620&"AQ M",6X,"NO. OF STEPPED VALUES(INCL. TIME=0.0)"/
24630&"AP IVALU",2X,"VALVE OPTIONS:1=POINT-BY-POINT"/
24640&,25X,"2=USE PROGRAMMED FUNCTIONS"/
24650&/"IF IVALU=1"/
24660&"AS N",6X,"NO.OF VALUES OF VALVE OPENING PATIOS TO BE READ"/
24670&,11X,"(INCL.0.0 AT TIME=0.0 AND 1.0 AT VALVE FULL OPEN)"/
24680&,11X,"THESE VALUES ARE DTS SEC. APART(SEE AP.ABOVE)"/
24690&"AT XBB(1)",1X,"N VALUES(SEPARATE WITH COMMAS) OF"
24700&/,11X,"VALVE OPENING PATIOS"/
24710&/"IF IVALU=2"/
24720&"AU SAG",4X,"NORMAL SAG AT 1/2 VALVE TIME(APPROX.=0.1)"/

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H5320S CONT.

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24730&)
24740 PRINT 6
24750 6 FORMAT(
24760&"A" TV1",4X,"INITIAL OPENING RATE(MINS. TO FULLY OPEN)"/
24770&"A" T1",5X,"VALVE MOTION STOPS AT T1 MINS."/
24780&"A" TLAG",3X,"VALVE HOLDS POSITION FOR TLAG MINS."/
24790&"A" TV2",4X,"FINAL OPENING RATE(MINS. TO FULLY OPEN)"/
24800&/"NOTE:NON-STEPPED OPENING;T1=TV1,TLAG=0.0,TV2=TV1"/
24810&/"NOTE:THE NEXT ITEMS CONCERN THE PRINTED OUTPUT"/
24820&"A" IPPIN1",1X,"1=PRINTS OUT ITEMS AA THRU AO,ABOVE"/
24830&,"11X,"0=DO NOT PRINT ITEMS AA THRU AO"/
24840&"BA IPPIN2",1X,"LOSS DISTRIBUTIONS;1=PRINT,0=DO NOT PRINT"/
24850&"BE IDEL1 PRINT 1ST AND EV. IDEL1*DTS SEC TO VALVE FULL OPEN"/
24860&"EC IDEL2",2X,"PRINT EV. IDEL2*DTS SEC. TO (M-1)*DTS SEC."//)
24870 4 CONTINUE
24880 PETRON;END
24890 SUBROUTINE HEADER(M)
24900 14840 FORMAT("08 H5320 18 15 EDGE"/"09 (15(,), (3X,3F6.2,F9.2,F7.2,
24910&"77.2,4F6.2,5F7.2))"/"10",18(1X,13)/"11",18(" 1"))
24920 14860 FORMAT("12 CUVVE DESIGNATIONS FOR H5320 ARE:"/"13 1=TIME",2
24930&4X,"10=CAVITATION PARAMETER"/"14 2=VALVE OPENING RATIO",9X,"11=PA
24940&TE-OF-PISE"/"15 3=CONTRACTION COEF.",11X,"12=VELOCITY AT REF AREA
24950&"/"16 4=LOG(VALVE LOSS COEF.)",7X,"13=VELOCITY HD AT REF AREA"/"1
24960&7 5=TOTAL INFLOW",16X,"14=VELOCITY HD AT VENA CONTR"/"18 6=LOCK W
24970&ATER SURFACE(W-S)",5X,"15=HEADLOSS THRU VALVE"/"19 7=W/S VALVE WE
24980&ALL W-S",10X,"16=TOTAL HEADLOSS"/"20 8=PIEZ HD BELOW VALVE",9X,"17
24990&=INERTIAL TERM"/"21 9=D/S VALVE WELL W-S",10X,"13=W-S DIFFERENTIAL
25000&L"/"22 UNITS FOR ABOVE VARIABLES ARE:"/"23 MINUTES=1",8X,"FT/MIN
25010&=11"/"24 NONE=2,3,4,10",4X,"FT/SEC=12"/"25 CFS=5",12X,"FT=13,14,
25020&15,16,17,13"/"26 FT-DATUM=6,7,8,9")
25030 WRITE(2,14840) (M,1=1,18)
25040 WRITE(2,14860)
25050 PETRON
25060 END

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